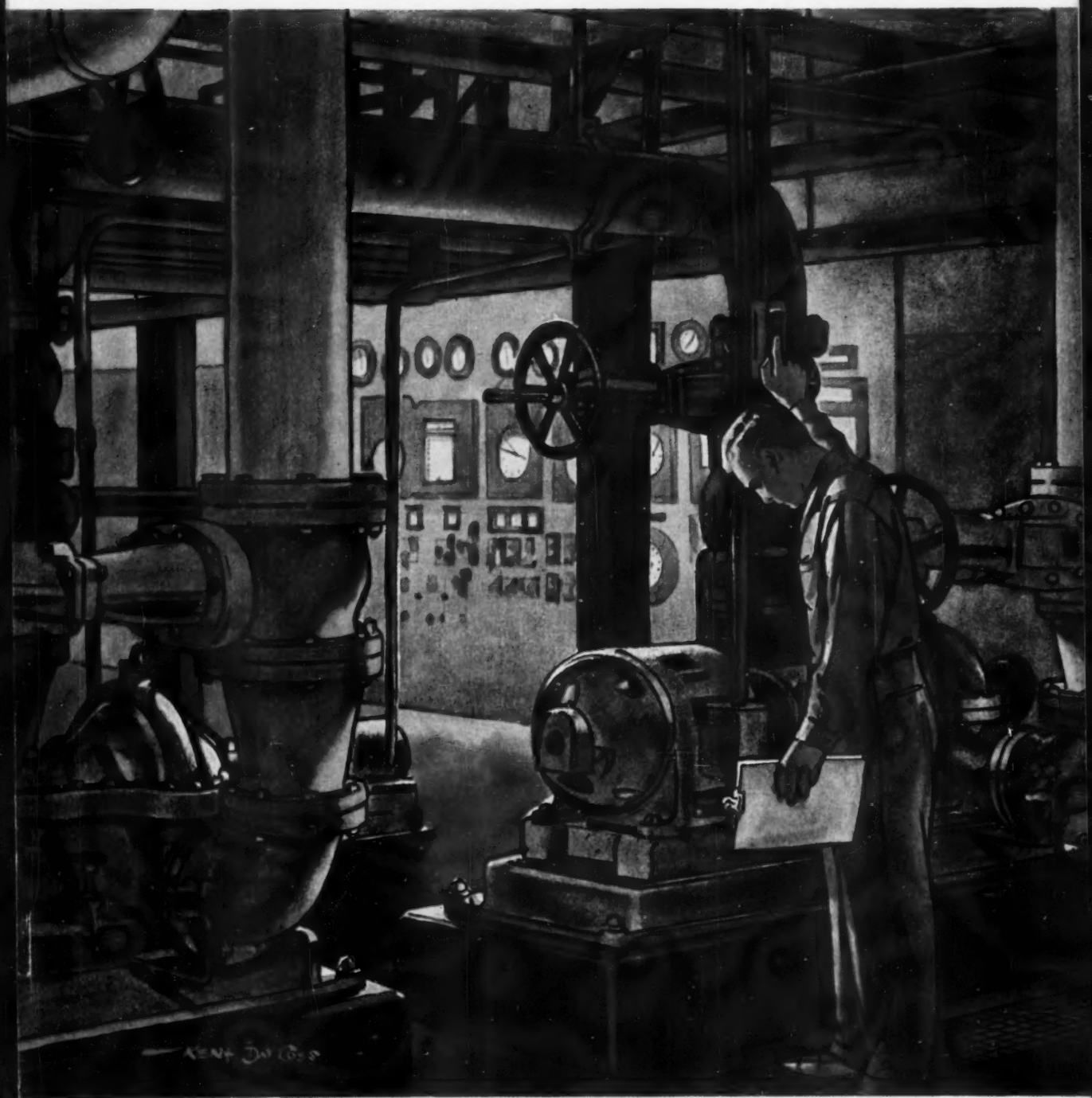
GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

Power

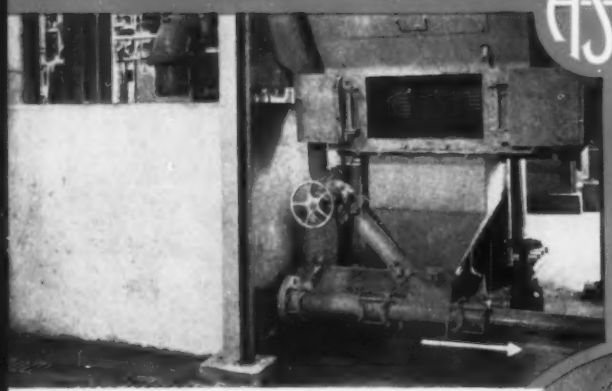
OCTOBER
1954·50¢

A McGRAW-HILL PUBLICATION



▲ PUMPS • a 32-page handbook–p 75

Modern Paperboard Mill Modern Ash & Dust disposal

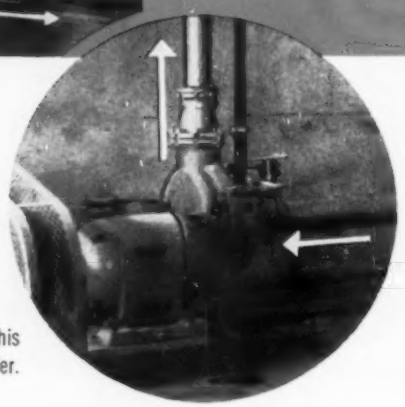


The A-S-H Hydro-Vacuum ash and dust handling system in this power plant of a new streamlined paperboard mill is evidence that hydraulic operation need not be limited to large installations. Because the suction of a Hydroseal Ash Pump is used to pull material through a long suctionline, the initial expense of high-pressure sluicing is avoided. Ash from a spreader-type stoker-fired boiler of 65,000 lb-per-hr capacity and flyash are discharged into an effluent lagoon. Through natural settling of solids, the water overflow into a nearby river complies with anti-pollution laws.

Stoker ash (gravity fed through a sizing grid) and flyash (gravity sluiced into surge tank) here start their journeys through 25 ft. of suction pipe to ash pump and then through 400 ft. of 4" discharge line to the lagoon. Water supplied to system at 50 psi.

Hydroseal Ash Pump—450 GPM capacity

Suction piping is arranged so that this pump will serve also an additional boiler.



In any boiler plant ...large or small, there is opportunity for the application of A-S-H engineering experience.

THE ALLEN-SHERMAN-HOFF CO. Dept. A—259 E. Lancaster Ave., Wynnewood, Pa.
Offices and Representatives in Principal Cities

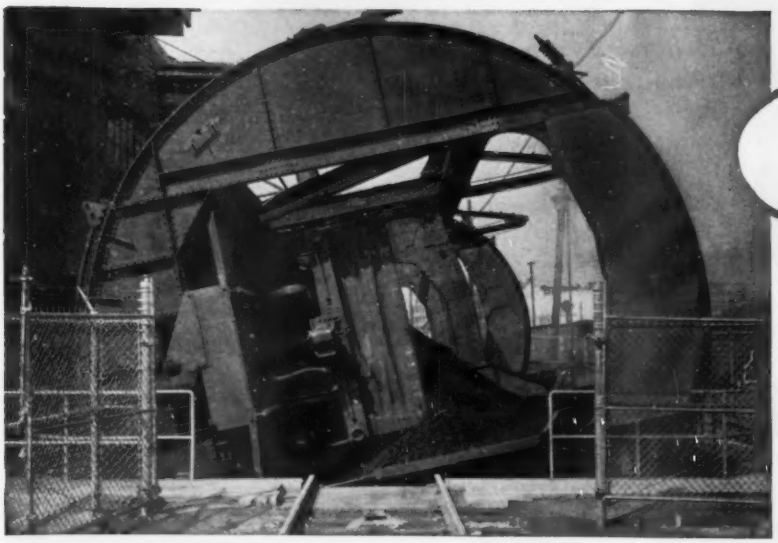
HYDROJET (hydraulic) **HYDROVAC** (pneumatic)

materials handling systems

Why Link-Belt builds both...

Car Shakers

EASIER ON CARS with minimum noise level . . . thanks to exclusive low-frequency vibration. The Link-Belt Car Shaker helps hopper cars empty themselves. Even hard-packed loads come "broom clean" in a matter of minutes. Especially good for damp, sticky materials. Write for Book 2345.



Rotary Dumpers

BOTTOMS UP . . . empties 90 ton car every 60 seconds or less by simply turning car upside down (including return to upright position)! That's how fast Link-Belt Rotary Car Dumper unloads gondolas. Simple, automatic, foolproof. Takes all oper-type cars—any length, width or height . . . up to 90-ton or 120-ton capacity. Book 2048-A has complete data.

Read how you can empty railroad cars fast, gently—at lower cost

YOU'LL get push-button car-unloading with either the Link-Belt automatic Rotary Dumper or the low-frequency Car Shaker. Both of these Link-Belt products can whisk gondola cars "broom-clean" in a remarkably short time.

We build the Rotary Dumper for large users . . . the Car Shaker for smaller operations. That's why you can be sure you get the right railroad car unloader for your particular requirements. Each of these precision-engineered products reduces operational hazards, minimizes injury possibilities, cuts costly demurrage charges.

If you empty a few gondola cars a day—or several thousand a week, call the Link-Belt district office nearest you. Get all the facts on how you can cut your railroad car unloading costs.

LINK-BELT

CAR SHAKERS and ROTARY DUMPERS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 13,202

Sure, that old pump still works,

but how much does it cost to keep?

That rugged old pump of yours may not be the bargain that it seems. Let's do some arithmetic. If the efficiency of the old pump is 75% vs. the 85% efficiency of the new pump, you are paying more to keep it than you would to replace it. That's because a new unit of equivalent output uses less power. Thus it soon saves its own cost — then begins to pay dividends.

Let's take a specific example — a small boiler feed pump

Old pump efficiency 63%	**99.5 BHP**
New pump efficiency 69%	**91.0 BHP**
	8.5 BHP Saving

On the basis of 1¢ per KWH, the 8.5 BHP saving for 8,760 hours (a year of continuous operation) amounts to $560. This saving, capitalized in 10 years at 4%, adds up to $6,700. Yet the price of the new pump that saves $6,700 is only $1,101.

What would the pump replacement profit be in your particular case? Your De Laval representative can tell you exactly — in dollars and cents — as soon as he has the basic facts on your present installation. Call him in today or write to De Laval for Pump Fax Bulletin which includes a valuable "power-savings" chart.

DE LAVAL *Pumps*

DE LAVAL STEAM TURBINE COMPANY
815 Nottingham Way, Trenton 2, New Jersey

Power

OCTOBER 1954 • VOLUME 98 NUMBER 10

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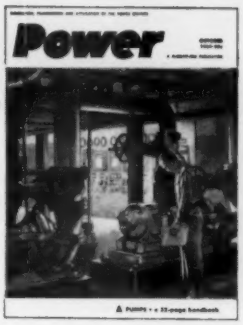


PUMPING, in the form of a Kent Day Coes painting, gets the cover spot this month, focusing attention on our handbook, pp 75-106. Work started on this cover way back in May with POWER staffers batting out ideas, Kent testing them against his artist's critical sense. When such give-and-take hammers out an idea pleasing to all, usual next step is gathering a sheaf of photos to guide Kent on technical details.

This time, one did most of the job—a shot of Peerless split-case centrifugals in a central-station hydrogen-cooling system. All Kent needed then was some posed photos of the "model"—and a lot of patience to cope with probing comments from the editors as the work progressed through "roughs" to the finished painting.

This month, Red Feather . . .

That means give generously—remember that 19,000 voluntary health, recreation, family-welfare and defense services will benefit from your giving.

Next month . . .

■ Making smart use of existing electrical facilities keynotes expansion at Danville, Pa. plant of Merck & Co. Look for details of design of this set-up, planned for tomorrow's loads.

■ *Regain* probably doesn't mean anything in your life unless you air-condition hygroscopic materials like textiles, tobacco, etc. But it'll mean more after you read a down-to-earth explanation coming up in November.

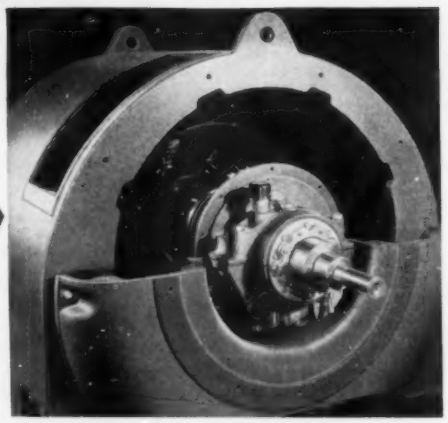
■ Wooden piping has an old-fashioned sound—but don't be fooled. It's a top modern answer to handling many corrosive liquids, as an upcoming article points out in three interesting pages.

. . . and future months

■ December will see a new departure—a 32-page special report addressed to executives of American industry. In businessman's language, it will show the profit possibilities in well-run power services, pave the way to clearer understanding and greater acceptance of your dollar-saving ideas and proposals.

new DESIGN...

more protection with full accessibility



* New Allis-Chalmers slip-ring motor with inspection cover and upper half of end shield removed. Note accessibility of brushes, protection of bearing.

ALLIS-CHALMERS LARGE SIZE SYNCHRONOUS AND WOUND-ROTOR MOTORS have been completely redesigned with longer stator yokes and shorter end shields. Collectors and brushes are located inside the yoke for protection against physical damage, dripping moisture, dust and dirt.

Capsule-type bearings give better bearing protection, too. The upper half of the end shield may be removed for inspection or cleaning of the interior of the motor without disturbing the exciter or exposing the bearing to the ravages of dirt, dust and oil contamination.

All leads enclosed — Both primary and secondary winding leads are brought out through separate conduit boxes. There is no loose wiring . . . no exposed leads anywhere.

Easy maintenance — Even though the new design offers maximum protection to brushes and collectors, internal parts are fully accessible for inspection and maintenance through large openings in the stator yoke. Opening covers are readily removed and are secured during operation by easy-operating, self-locking fasteners.

Get details now — This new design is available from approximately 250 hp at 300 rpm and up, in drip-proof and splash-proof construction. Call your Allis-Chalmers representative for complete details or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 05R8183. A-4464

ALLIS-CHALMERS

Power

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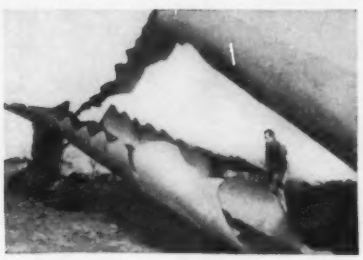
...with Power readers...



WELDING . . .

Welds are the only things that held in this 30-in. line when a mile of it exploded, points out our good friend J F Lincoln, president of Lincoln Electric Co of Cleveland.

He writes: "Welding progress is held back by limitations placed around the welding process by unduly severe codes, rules and regulations. But with modern arc-welding equipment, electrodes and technique, it's almost impossible to make a weld weaker than a riveted joint.

"It's time welding be given its proper place in manufacturing methods, without

(*Continued on page* 216)

...lines and bylines

PUMPS!

PUMPS!

PUMPS!

Hicks, corncob, typewriter, pile of pump data

That's all Ty Hicks has been thinking about for the past six months. Reason: The 32-page handbook section beginning on p 75. To give you an idea of what such a job takes, here are a few statistics: Ty wrote to over 200 pump manufacturers, received more than 3000 pieces of current literature. Then he got on his horse and traveled some 4000 miles to talk with pump designers and users.

Back at home base he spent two full months digesting the vast mass, figuring ways to present the heart of it in graphic, readable style. Toughest job, as in all handbook sections, was to keep boiling away surplus words to pack most information in least space.

But words are only part of the job, a modest part at that. Because good illustrations tell more than words, Ty put in a lot of time with Art Editor Charlie Marschalek, selecting drawings and pictures, organizing them to get ideas off the page to you, fast and clear.

With Assistant Editor Al Thornton as liaison, Ty kept in touch with draftsmen and artists in our illustration department, read proofs, checked copy with pump specialists. Compared to squeezing this mass of information into 32 highly pictorial pages, writing a book would have been easy, says Ty, with feeling. We think you'll agree.

H N Hickok

ELECTRICAL SWITCHGEAR is a subject H N Hickok really knows. We didn't have room to introduce him last month, but you probably read his article on p 81, Sept issue.

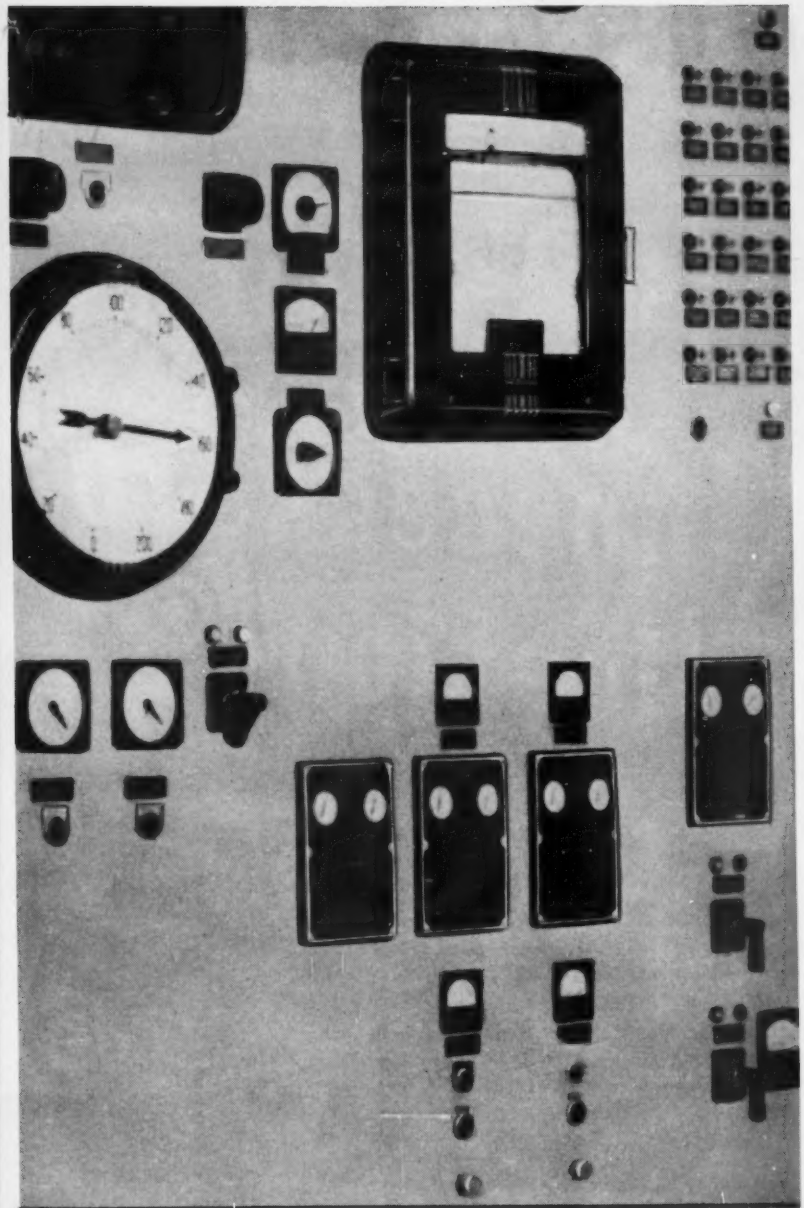
He graduated in engineering from U of Texas in '47 with BS in Eng'ring. Joined GE's engineering test program in switchgear, motors and generators, and large steam turbines.

Next he went to Philly Works for several years, first as a design, then as a proposition engineer. From there to Industrial Application Engineering Section in Schenectady, working in industrial power, chemical and petroleum, and paper and textile engineering subsections for three years as an application engineer. Now at the Houston office in the same capacity. His hobbies are photography, model railroads, building electronic equipment, shop work, traveling, music and gardening.

Many companies are currently enjoying substantial dollars and cents benefits through the use of pressure-fired units.

While engineers had long recognized the advantages that would result from all-forced-draft, pressure-fired boiler operation, overcoming the obstacles that blocked the development of actual pressure-tight units was an engineering achievement of major proportions. And the fact that today some of the largest coal-fired units ever operated have no induced draft fans is the strongest possible indication of the success and acceptance of B&W's pressurized-furnace design.

Sixty-five B&W Pressure-Fired Boilers—many with operating records spanning several years — now serve a total generating capacity of more than 5,500,000 kw, in power plants across the country. Fifty additional B&W units to serve another



PRESSURE-FIRING

B&W
Pressure-Fired Boilers
For a Total Generating
Capacity of Over

10,500,000 KW

Appalachian Electric Power Co.
Arkansas Power & Light Co.
Central Louisiana Electric Co.
Central Power & Light Co.
City of Jacksonville
City of Lansing, Mich.
City Public Service Board, San Antonio
Commonwealth Edison Co.
Consolidated Edison Co. of N. Y., Inc.
Dallas Power & Light Co.
El Paso Electric Co.
Houston Lighting & Power Co.
Indiana & Michigan Electric Co.
Indiana-Kentucky Electric Corp.
Jersey Central Power & Light Co.
La Electricidad De Caracas
Ohio Edison Co.
Ohio Power Co.
Ohio Valley Electric Corp.
Oklahoma Gas & Electric Co.
Philadelphia Electric Co.
Public Service Co. of New Mexico
Public Service Co. of Oklahoma
Public Service Division, Commonwealth Edison Co.
Public Service Electric & Gas Co.
Southern Nevada Power Co.
Southwestern Gas & Electric Co.
Texas Electric Service
Texas Power & Light Co.
Tucson Gas, Electric Light & Power Co.
West Texas Utilities Co.
Wisconsin Power & Light Co.

5,000,000 kw of generating capacity, are being built.

If you are interested in pressure-firing, we will be glad to discuss detailed performance records of the many units now installed. Their day-to-day operation under a variety of fuel and load conditions will indicate clearly the long range availability and savings possible with this type of unit. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, New York.

BABCOCK & WILCOX
BOILER DIVISION

G-670

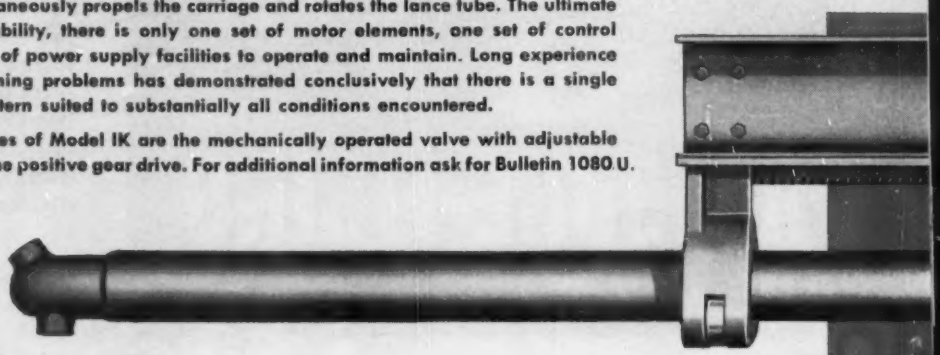
A Diamond Policy for Decades:

"Keep It Basic" "Avoid Unnecessary Complications"

Diamond engineers have always felt that it isn't enough to design a mechanism that will do a particular job. It is also important to make that mechanism as simple and dependable as possible. It has been a Diamond policy for decades to *"keep it basic"* . . . to avoid unnecessary complications that make trouble for users.

Diamond Soot Blowers are simple, effective, dependable. Typical of this is the single motor drive on the Model IK Long Retracting Blower. One motor working through a simple system of rugged gears simultaneously propels the carriage and rotates the lance tube. The ultimate in simplicity and reliability, there is only one set of motor elements, one set of control elements, and one set of power supply facilities to operate and maintain. Long experience with all kinds of cleaning problems has demonstrated conclusively that there is a single universal cleaning pattern suited to substantially all conditions encountered.

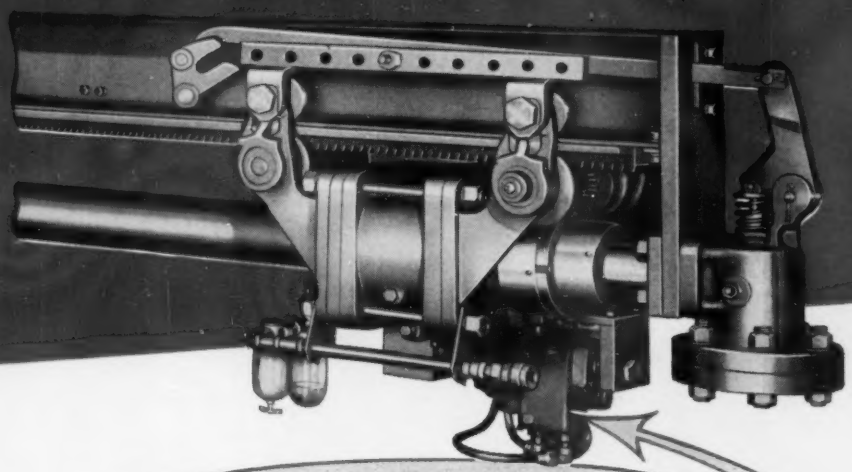
Other important features of Model IK are the mechanically operated valve with adjustable pressure control, and the positive gear drive. For additional information ask for Bulletin 1080 U.



The many advantages of Diamond Model IK Long Retracting Blowers are explained in Bulletin 1080 U, write for a copy.

6910

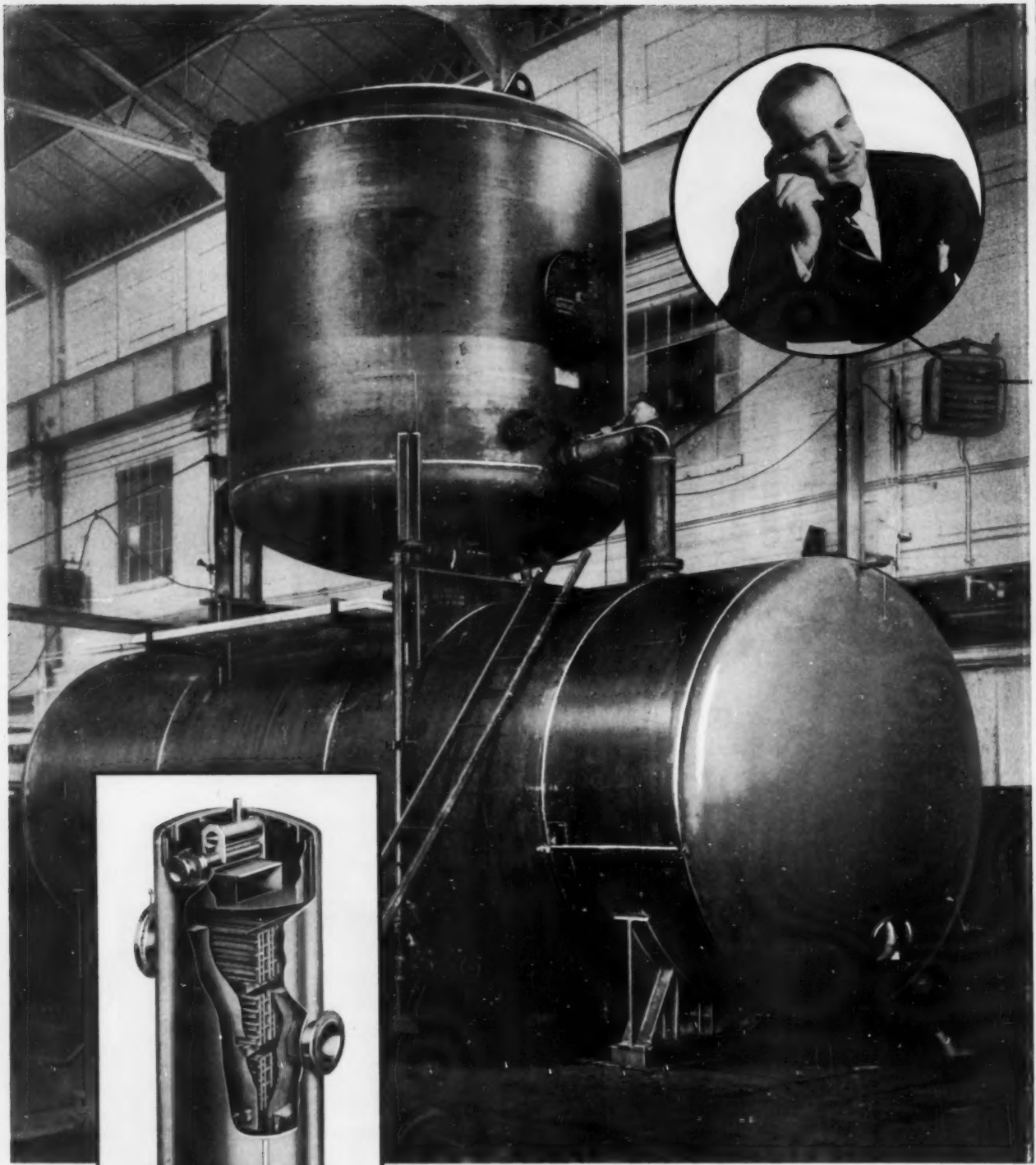
For Example... SINGLE MOTOR DRIVE on DIAMOND Model IK Long Retracting Blowers

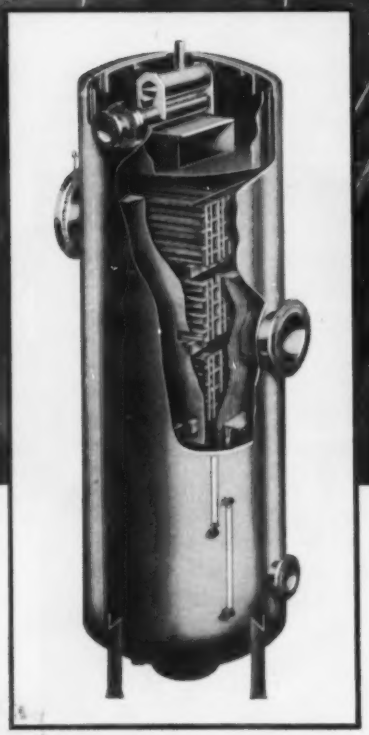


A Single Motor (air or electric)
Both Rotates and Propels
the Long Lance Tube

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario





A 1,000,000-lb-per-hr deaerating feedwater heater mounted on its storage tank, just after passing its hydrostatic test in the Elliott shops. This is one of six similar units for an important utility.

◀ The latest design Elliott tray-type deaerating heater. This one is the multiple tray compartment type, designed to deliver water with commercial zero oxygen content.

N4-1

Back of **ELLIOTT** Deaerating Heaters

ON-THE-SPOT FIELD SERVICE

In discussing deaeration problems with your Elliott sales engineer, you are getting the cooperation of an expert, factory-trained from the ground up in every aspect of deaeration, familiar with its principles as established step by step from Elliott's first pioneering unit of a generation ago, to the present space-saving, easily serviced design.

But that isn't all —

Spotted in strategically selected centers all over the country, are a corps of Elliott field service men, thoroughly capable in the diagnosing of operating difficulties and in their correction.

Beyond this, trained personnel in the home shops in Jeannette, Pennsylvania, stand ready when needed to travel to a trouble-spot as fast as the swiftest airplane can get them there.

So—when it's a deaeration problem, either a projected installation or the servicing of one already operating, pick up the phone and call your Elliott sales engineer. Or if more convenient write or wire Elliott Company, Deaerator and Heater Department, Jeannette, Pa.

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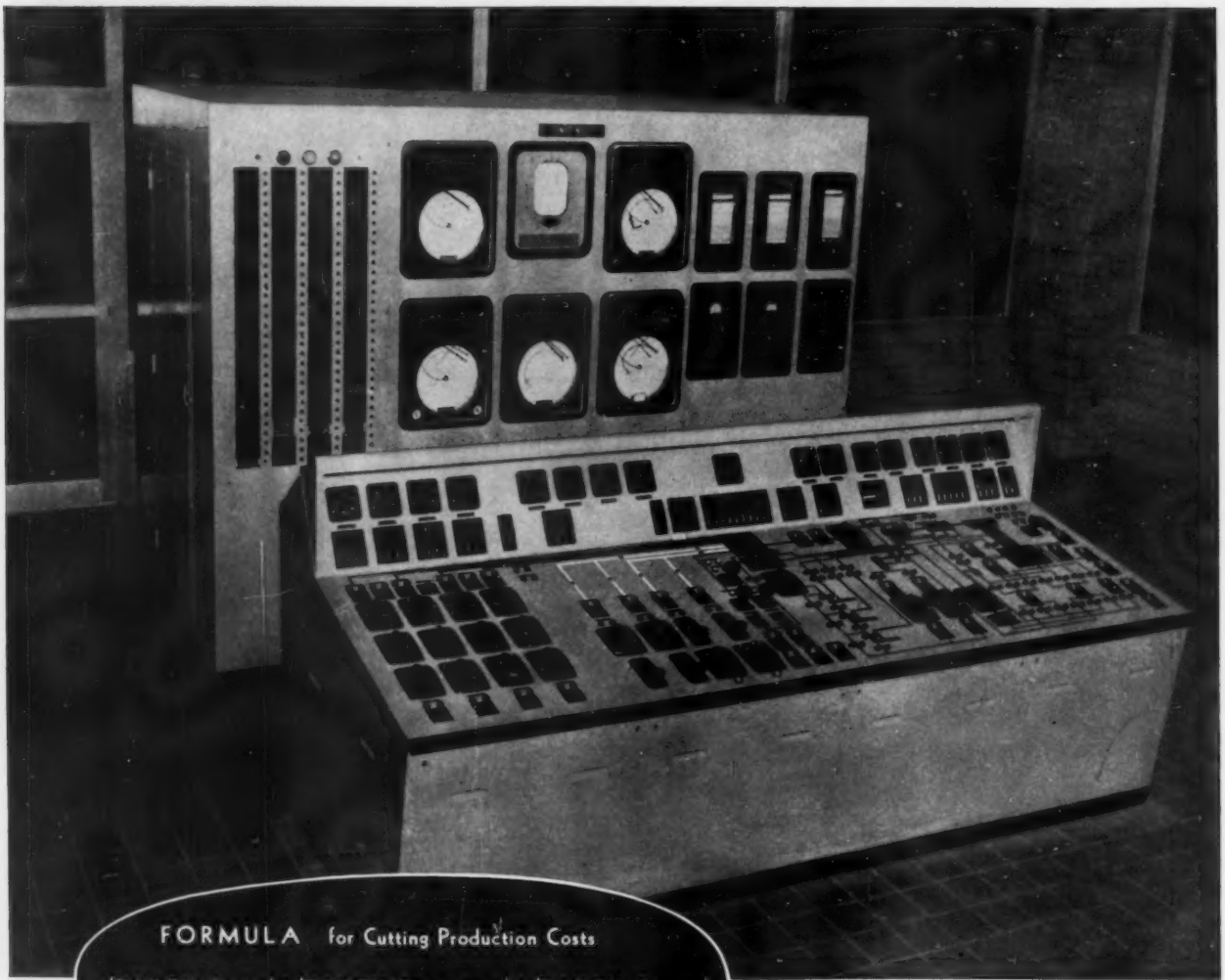
TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

How to Increase the Return on



FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

Control Center for 60,000 kw reheat boiler-turbine Unit No. 1 at Danskammer Point Steam Station of Central Hudson Gas & Electric Corp. Bailey MINI-LINE Equipment on benchboard gives operators fingertip control while larger recorders on vertical board show operating trends and make permanent records. Duplicate Bailey Equipment has been purchased for Unit No. 2.

Engineering and construction by Burns and Roe, Inc.

Your Boiler Room Investment

★ There are four important ways to increase the return on your Boiler Room Investment:

More power per fuel dollar
Less outage
Delivery of steam at design conditions
Greater operating safety

None of these items taken alone will produce the highest return—it takes all four working in close harmony.

That's where co-ordinated controls by Bailey Meter Company help. And here is why Bailey Controls are your best choice:

1. Complete Range of Equipment—fully co-ordinated. You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. Engineering Service—backed by experience. No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you. Bailey Meter Company's Sales-Service Engineers are located in more Industrial Centers than those of any other manufacturer of Boiler Control Systems; you get prompt, experienced service with a minimum of travel-time and expense.

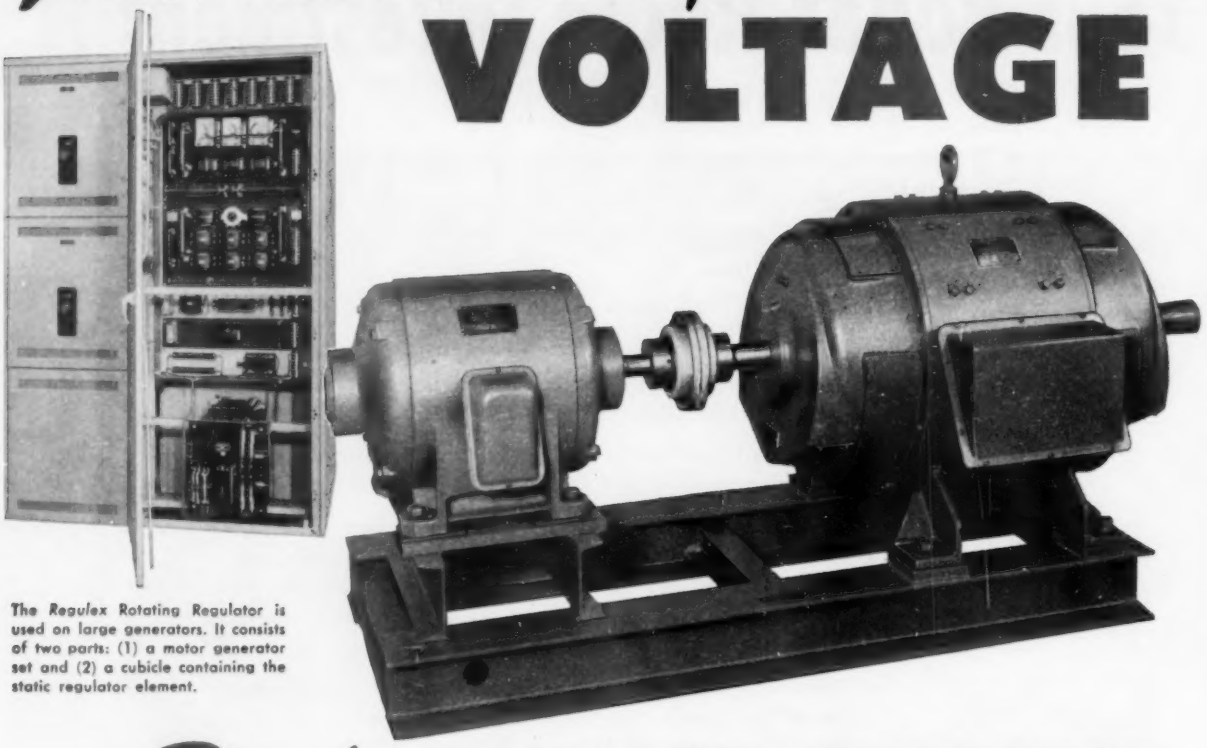
For better "boiler-room investment" efficiency—for more power per fuel dollar, less outage, steam at design conditions, and greater operating safety—you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More Power To You!"

A-115-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

Fast, accurate, dependable VOLTAGE



The *Regulex* Rotating Regulator is used on large generators. It consists of two parts: (1) a motor generator set and (2) a cubicle containing the static regulator element.

Regulex ROTATING REGULATOR

★ **Maximum Productivity from New Generators**
★ **New Efficiency from Present Installations**

Regulex voltage regulators incorporating automatic minimum excitation permit generator operation close to the stability limit . . . much closer than manual operation allows. The sensitivity and exceptional response of the *Regulex* voltage regulator and associated equipment establish and maintain a safe ratio between generator load and field current . . . increase operating limits at any given power factor load . . . assure the proper reactive kva division. The *Regulex* voltage regulator does not require multiple special fields in the exciter — may be applied to any standard shunt machine. Write for literature. A-4189

New Magnetic and Electronic Amplifiers

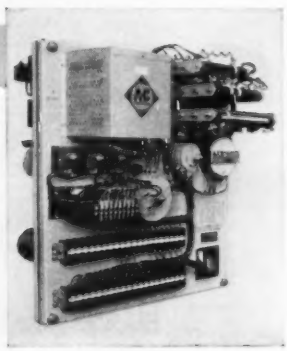
Versatile "Tools" Used in Solving Your Particular Voltage Regulation Problem

For special industrial and military regulating systems, added flexibility is obtained by using magnetic and electronic amplifiers. These components *supplement* but do not replace the *Regulex* rotating amplifier in most applications.

The magnetic amplifier is used primarily where reversible output from the amplifier is not required. Special exciter design is eliminated in such applications. The shock-proof characteristics of the magnetic amplifier make it particularly adaptable to military voltage control.

Electronic amplifiers are used only on applications that require exceptionally high sensitivity.

Applications of magnetic and electronic amplifiers for purposes other than voltage control include speed, current, and tension regulation.



Voltage regulator with current limiting device. Used for control of static rectified dc power supply.

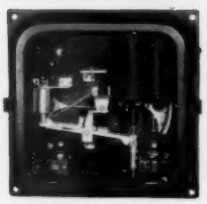
REGULATION

For ANY *Size Generator*

Rocking Contact VOLTAGE REGULATORS

dc Applications

The Type VD Regulator has been designed to meet the demands of voltage or current characteristics of dc machine operation. Resistors are cut in and out of the exciter shunt field by the *Rocking Contact* sector. No sluggish, time wasting relays. No vibrating or sliding contacts to wear out. A small movement of the *Rocking Contact* sector over a curved commutator covers the entire regulating range. Type VD regulators are available for all dc generators. Write for Bulletin 14B6137A.



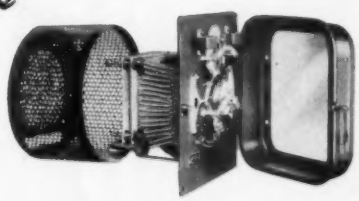
VD-2 Regulator for dc generators from 10 kw at 80 rpm to 200 kw at 3600 rpm

ac Applications

Types V-00 and 221 Regulators

FOR SMALL GENERATORS

Rocking Contact Voltage Regulators are available in two types for use on small ac generators with direct-connected exciters — Type V-00 for generators to 157 kva maximum at 3600 rpm; Type 221 for generators to 438 kva maximum at 3600 rpm. These regulators can be modified for temperature compensation, shock mounting or other special requirements. Bulletin 14B6143A gives details.



Types A, B, & C Regulators

FOR MEDIUM SIZE GENERATORS

Types A, B, and C Regulators differ only in kva range.

Type A Regulator—for ac generators, 125 kva at 257 rpm to 1750 kva at 3600 rpm.

Type B Regulator—for ac generators, 1000 kva at 257 rpm to 6250 kva at 3600 rpm.

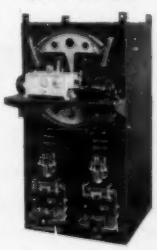
Type C Regulator—for ac generators from 3125 kva at 257 rpm to 25,000 kva at 3600 rpm.

All have guaranteed sensitivity of plus or minus 0.5%. Write for Bulletin 14B6035B.

FOR LARGE GENERATORS

Type J *Rocking Contact* Regulators are of the exciter field rheostatic type designed for the control of large synchronous machines. This regulator consists of two parts: (1) a voltage sensitive torque motor control element for panel mounting; (2) a motor-operated exciter rheostat with high speed field forcing contactors. Write for Bulletin 14B6015A.

Type J Element



Motor-Operated Rheostat

Regulex and Rocking Contact are Allis-Chalmers trademarks.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (¼% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

Write for bulletin 54-1074-222 and get the important facts.

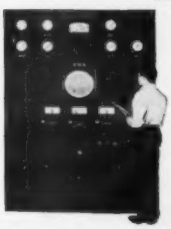
Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 3, INDIANA

for the man considering a PACKAGE BOILER

new all-electric METERING TYPE PACKAGED CONTROL by HAYS



Now available for *all* makes and sizes of water tube type package boilers is the new all-electric, metering type Hays packaged control.

Metering type control provides maximum combustion efficiency regardless of the fuel burned because it *actually meters* the fuel flow and air flow, and automatically maintains the desired ratio. No adjustments are needed when changing fuels or oil burner tips.

All-electric operation includes not only safety devices but also steam, fuel, and air controllers and valves—uses only the normal source of AC voltage. No compressed air is required.

Fully automatic, safe and reliable operation is assured because Hays maintains the same industrial quality built into the largest utility combustion control system and it is factory tested before shipment.

Complete package in one simple and inexpensive to install panel board.

Write today for fact-filled Bulletin 53-1088-239.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

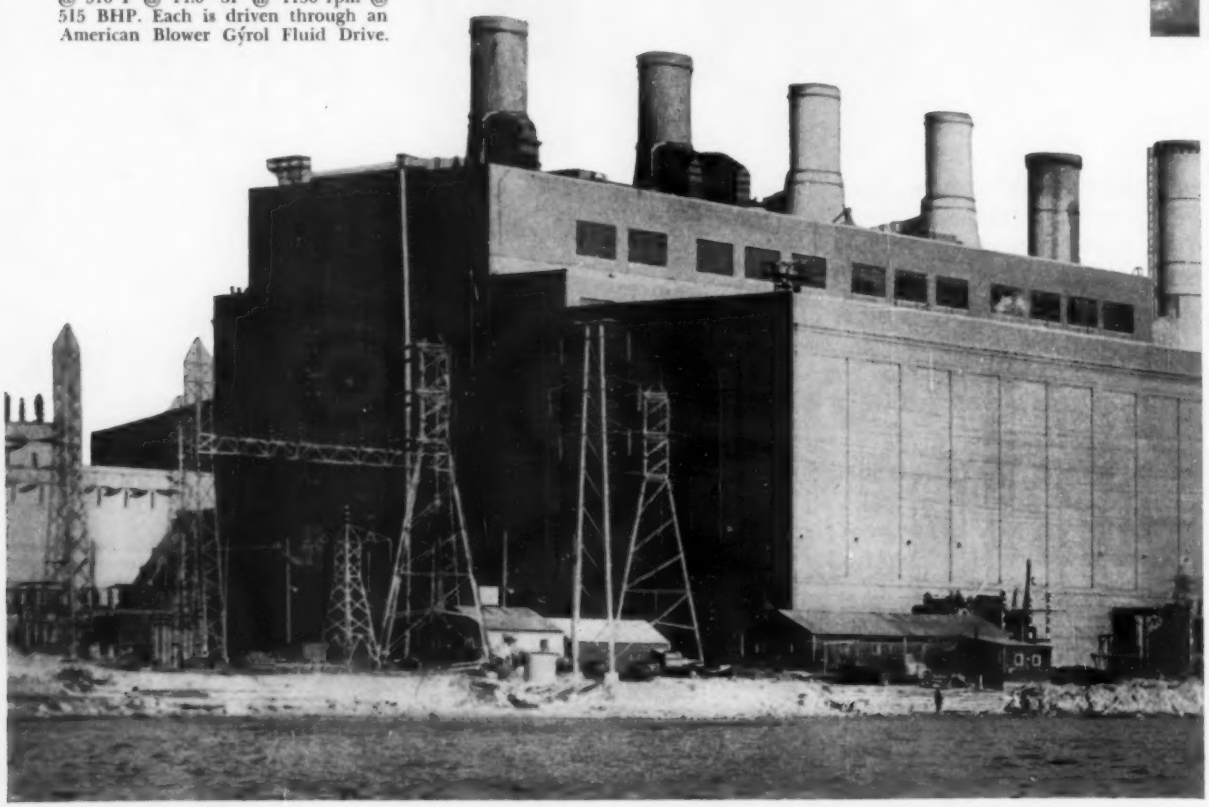
THE hays CORPORATION

MICHIGAN CITY 3, INDIANA

Niagara Mohawk expands

Installed at Niagara Mohawk's Oswego Station are two American Blower Induced Draft Fans, rated 181,000 cfm @ 310°F @ 14.0" SP @ 1150 rpm @ 515 BHP. Each is driven through an American Blower Gyrol Fluid Drive.

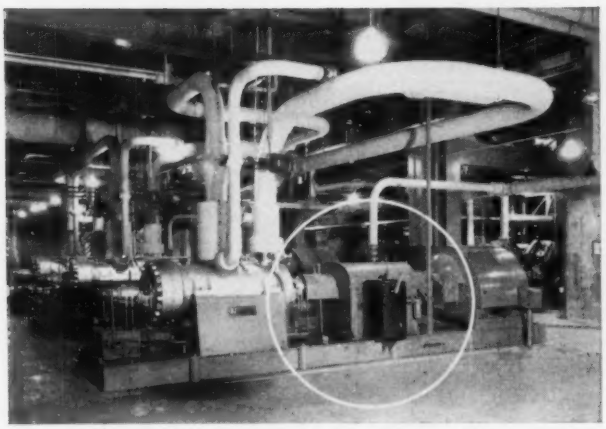
Installed at Dunkirk Station are American Blower secondary air fans with inlet vane control. Rated capacity, 112,000 cfm, 12" wg, 1190 rpm.



Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL

capacity to 2,682,000 kw

American Blower
Reports on Progress in Power



American Blower Gyrol Fluid Drives control the speed of Boiler Feed Pumps at Dunkirk Steam Station. Rated capacity of each Fluid Drive is 1,250 hp at 3,500 rpm. Niagara Mohawk also uses Gyrol Fluid Drives for fan control.

Niagara Mohawk Power Corporation is one of the world's largest private producers of electrical power. With 84 hydro-electric and seven steam-electric stations, Niagara Mohawk serves a 22,000 square-mile territory in New York State, and supplies electricity to 3,100,000 people.

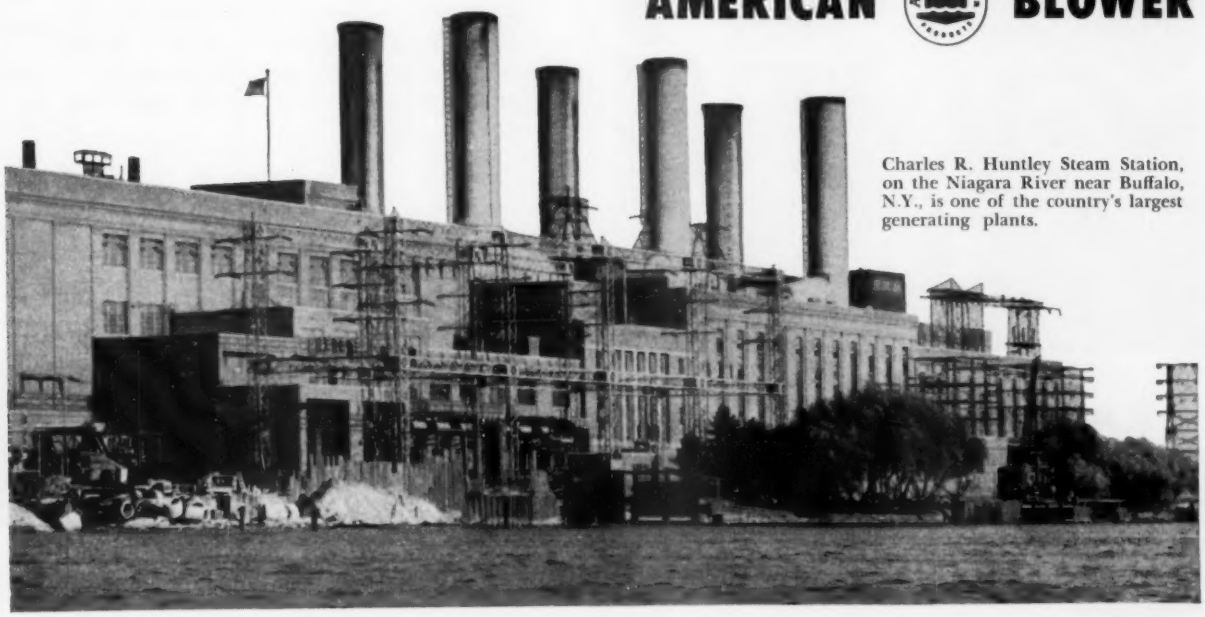
To keep pace with the growing power needs of its customers, Niagara Mohawk has spent a total of nearly $350,000,000 for new and expanded facilities since the war. During 1953 and early 1954, approximately 300,000 kw of generating power were added, bringing the system's total rated capacity to a mighty 2,682,000 kw.

American Blower has played an important role in this expansion program. It has supplied many of Niagara Mohawk's Stations with Mechanical Draft Fans and Gyrol Fluid Drives for boiler feed pump and fan control. Recognized for its dependability and economy of operation, American Blower equipment – including Dust Collectors, Fly Ash Precipitators and Heavy Duty Steam Coils, is used extensively in power plants throughout the country.

If you are planning to expand or modernize your facilities, get in touch with your nearest American Blower Branch Office, or write us direct. We will be pleased to work with you on your air-handling problems.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, CANADA
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER



Charles R. Huntley Steam Station, on the Niagara River near Buffalo, N.Y., is one of the country's largest generating plants.

TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

"this is

● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NEW! WIDER VISION!

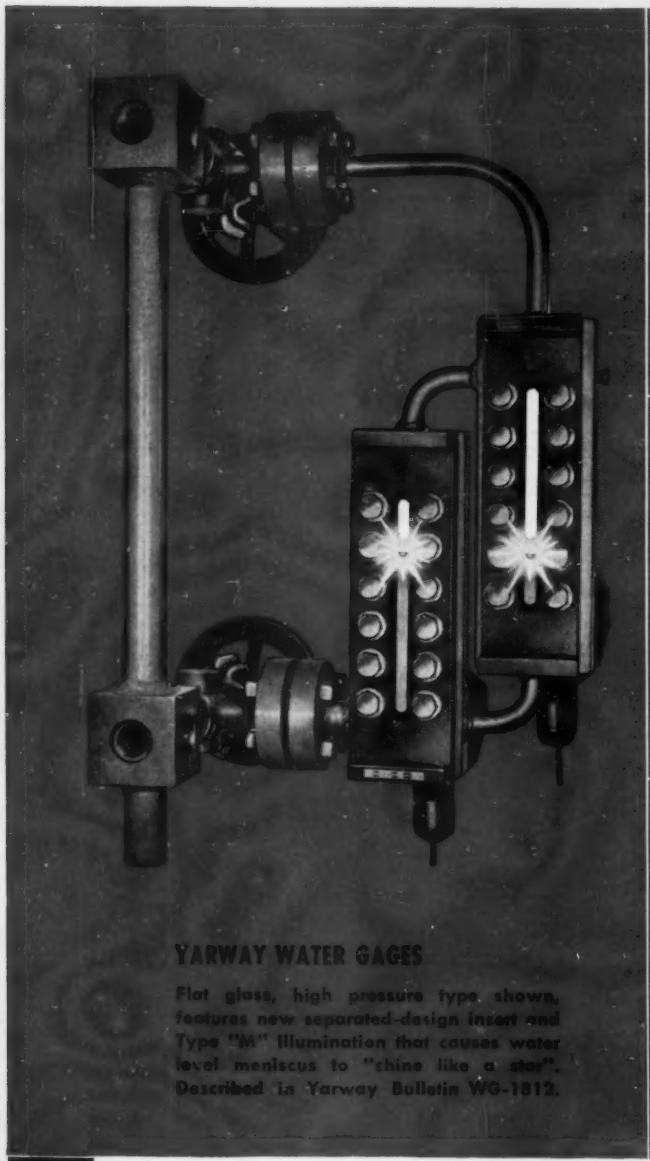
Clear, brilliant readings from any angle, are possible with the new "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1155.

Described in Yarway Bulletin WG-1824.

YARWAY®

good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

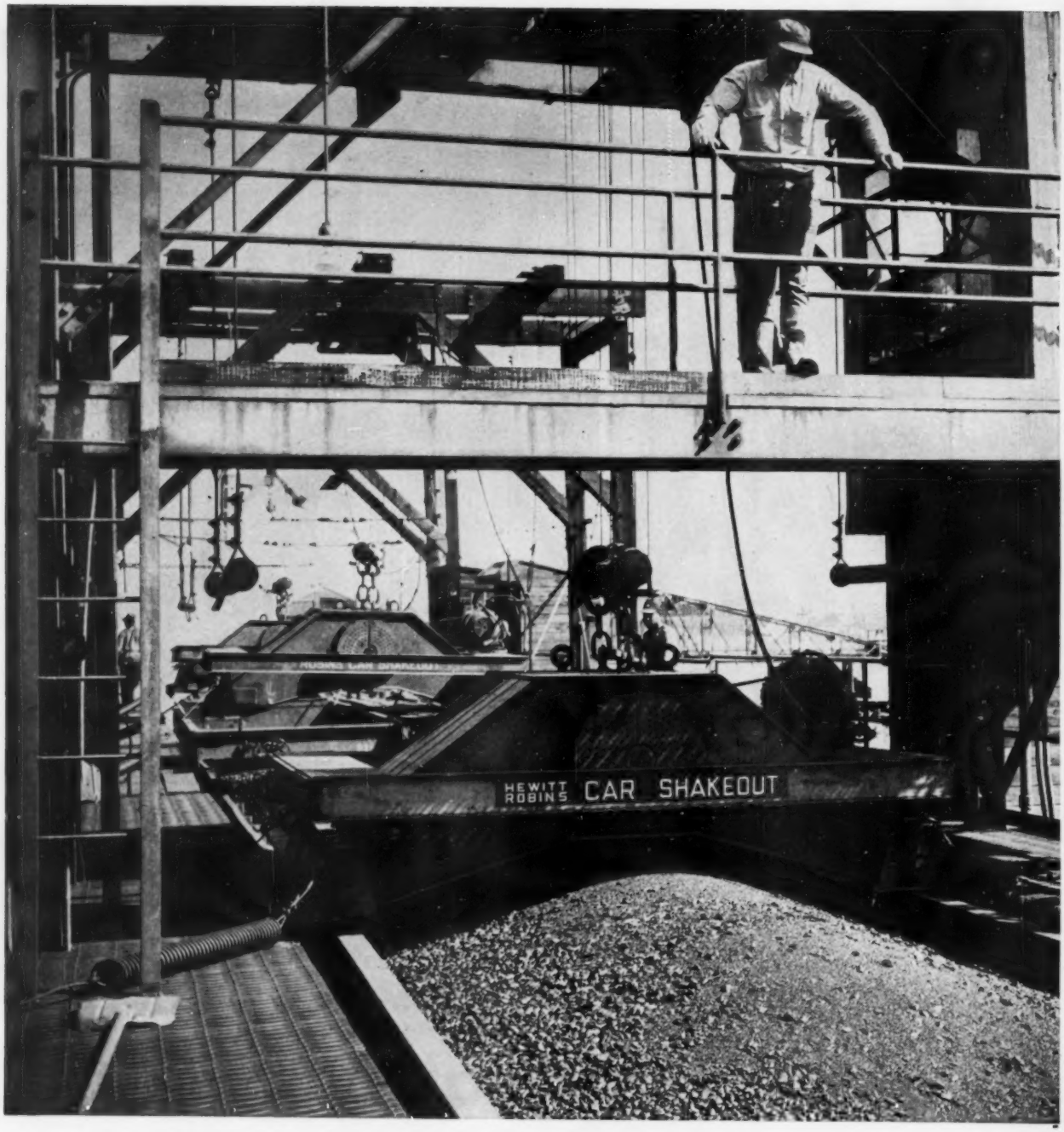
YARWAY TELEVISION

Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant.
Described in Yarway Bulletin WG-1813.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

Five HD Car Shakeouts



HEWITT-ROBINS

EXECUTIVE OFFICES, STAMFORD, CONNECTICUT

Unload Up To 2,600 TPH

22,070,523 Ton Total in 72 Months of Operation since 1946

CUSTOMER'S PERFORMANCE RECORD

EQUIPMENT: Five Hewitt-Robins HD (Heavy Duty) Car Shakeouts in line system.

LOCATION: Docks of the Rail to Water Transfer Company, Chicago, Illinois.

OPERATION: Unloading coal from hopper cars for transfer to Great Lakes' freighters.

PERFORMANCE: These five Hewitt-Robins HD Car Shakeouts unload from 1,900 to 2,300 tons of coal per hour (Tonnages handled are limited to the maximum capacity of other equipment in the complete coal handling system) . . . a total of over 75,000 hopper cars during the 1953 normal nine month operating season. Three Car Shakeout units started operations in 1946—two additional units were added to the line system in 1951—altogether they unloaded a total of 22,070,523 tons since 1946!

RESULTS: Total tonnages jumped from 1,349,310 tons in 1946 to 4,007,000 tons unloaded in 1953. Rail to Water Transfer Company reports the units . . . save time . . . save money . . . have generally paid for themselves in two seasons of operation.

ENGINEERING DATA

MODELS: 5-ton HD (Heavy Duty) . . . 3½ ton GS (General Service) . . . Both fit all hopper bottom cars in domestic service.

DUTY: GS Model generally recommended for 10 cars per day, HD Model up to 100 cars per day handling wet, compacted or partially frozen loads. (Capacity figures vary depending upon characteristics of material.)

SPECIFICATIONS: 5/32" stroke—1,500 vibrations per minute (easily adjustable for specific applications) . . . Motor platform supported on coil springs to protect motor from vibration . . . HD Model vibrating frame of welded construction throughout, stress relieved after welding . . . GS Model fabricated from rolled sections of riveted construction . . . Both models available with recommended companion twin-hook Car Shakeout Hoist.

Patent No. 2,504,789

Here is a partial list of

HEWITT-ROBINS PRODUCTS

that will help you cut handling costs and increase operating efficiency.

MACHINERY

- Belt Conveyors
- Belt & Bucket Elevators
- Car Shakeouts
- Conveyor Idlers
- Dewaterizers
- Mechanical Feeders
- Foundry Shakeouts
- Mine Conveyors
- Reclaiming Systems
- Screen Cloth
- Stackers & Trippers
- Vibrating Conveyors & Screens

INDUSTRIAL RUBBER PRODUCTS

BELTING:

- Conveyor
- Elevator
- Transmission

HOSE:

- Acid
- Air & Air Drill
- Barge Loading
- Dust Suction
- Fire
- Fuel Oil & Gasoline
- Gasoline Pump
- Mud Pump Suction
- Oil Suction & Discharge
- Propane-Butane
- Road Builders'
- Rotary Drilling
- Sand Blast
- Sand Suction
- Sea Loading
- Servall®, All-Service
- Steam
- Tank Car & Tank Truck
- Vacuum & Air Brake
- Water & Water Suction
- Welding, Twin-Weld®

•

For information and service on industrial rubber products, contact your Hewitt-Robins Industrial Supply Distributor. Through his complete stock of Hewitt-Robins Rubber Products, and his familiarity with local field conditions, he can fill your supply needs promptly and correctly. See Classified Phone Book for the Hewitt-Robins Industrial Supply Distributor serving your area.

1908

INCORPORATED

DOMESTIC DIVISIONS: Hewitt Rubber • Robins Conveyors • Robins Engineers • Restfoam
FOREIGN SUBSIDIARIES: Hewitt-Robins (Canada) Ltd., Montreal • Hewitt-Robins Internationale, Paris, France • Robins Conveyors (S. A.) Ltd., Johannesburg • **EXPORT DEPARTMENT:** New York City.

Original Sunbury Steam Electric Station, built by Thomas A. Edison in 1883.

from Edison's tiny Sunbury of 1883 to

SUNBURY TODAY

a gigantic stride in electric light's sweeping progress

In providing only the most efficient steam generating equipment for the modern Sunbury Steam Electric Station of the Pennsylvania Power & Light Company, as well as for many other outstanding central stations, FOSTER WHEELER has made a significant contribution to

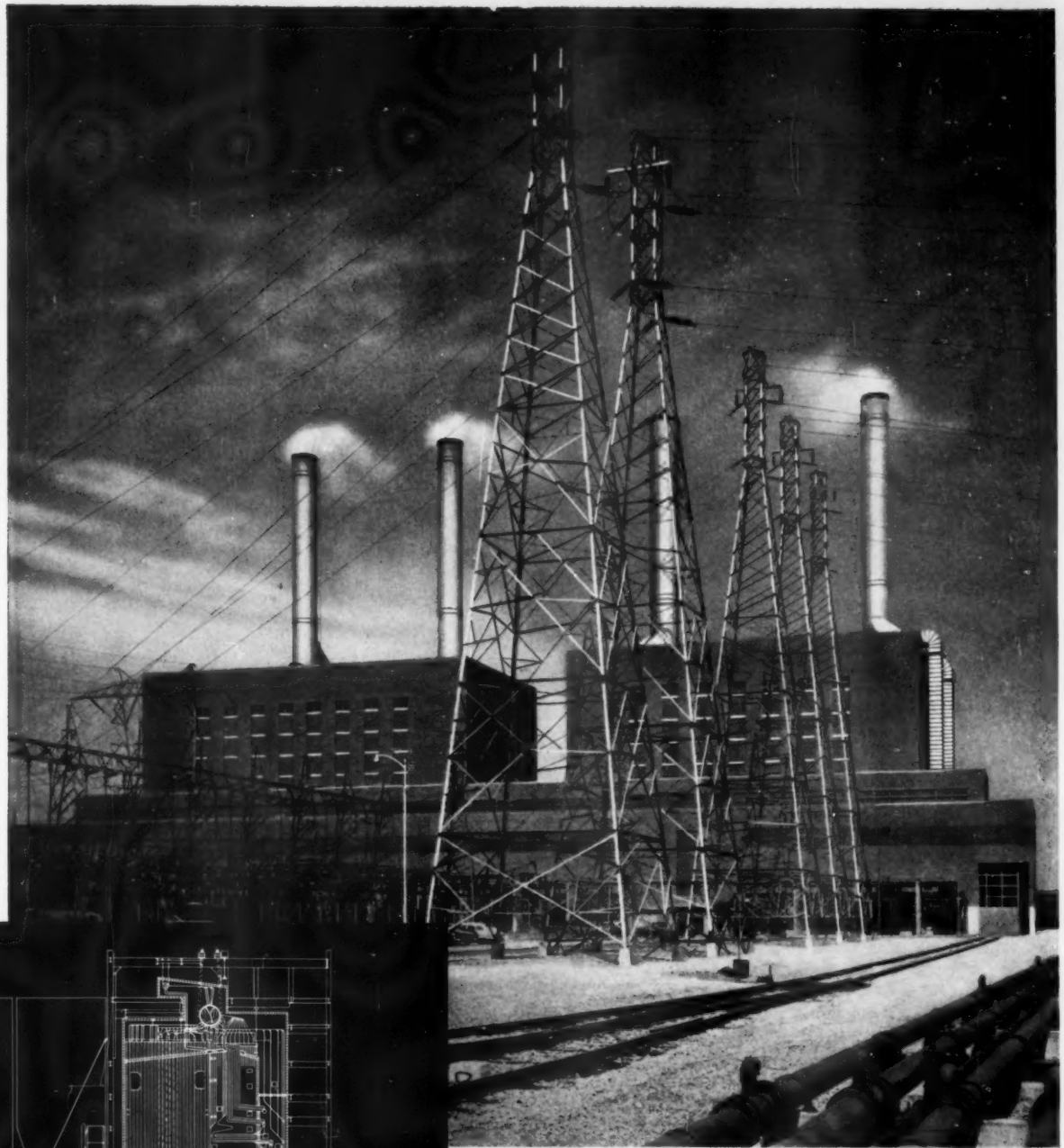
LIGHT FOR FREEDOM POWER FOR PROGRESS

When on July 4, 1883 Thomas Alva Edison closed the switch of the first three wire steam-electric station at Fourth and Vine Streets, Sunbury, Pa., the great inventor was initiating the public use of electric service. The sweeping progress that electric lighting was destined to accomplish in the years that followed is a tribute to Mr. Edison's genius and vision.

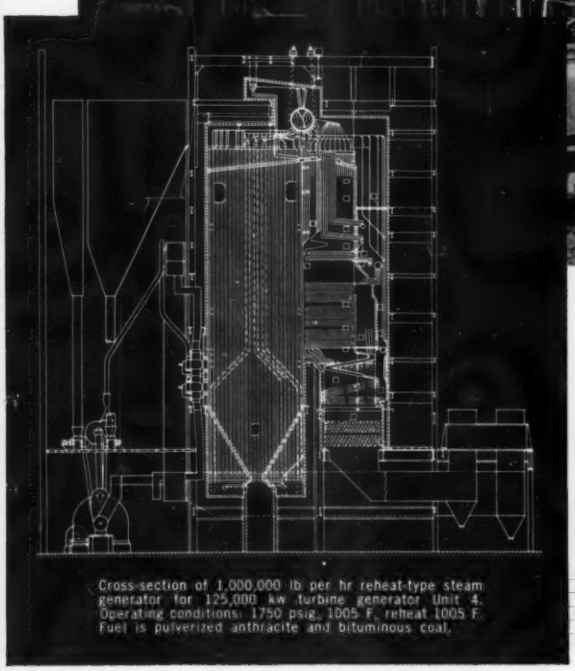
Today, located on the west bank of the Susquehanna, almost within view of the site of Edison's original building, stands its direct descendant -- the mammoth Sunbury Steam Electric Station of the Pennsylvania Power & Light Company. A striking example of the industry's rapid development, this modern plant's output assists in serving the home, farm, factory and community needs throughout an area of 10,000 square miles in Central Eastern Pennsylvania.

Six Foster Wheeler Steam Generators now serve turbines No. 1, 2, 3 and 4 totaling 425,000 kw capacity. When ultimately completed, Sunbury will have a capacity of more than 800,000 kw. *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FOSTER WHEELER

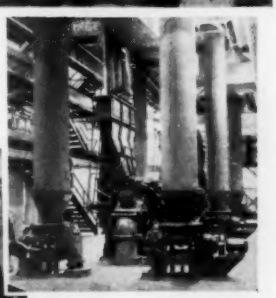


View, looking north, of the Sunbury Steam Electric Station of the Pennsylvania Power & Light Co., Sunbury, Pa. Ash disposal piping in foreground.

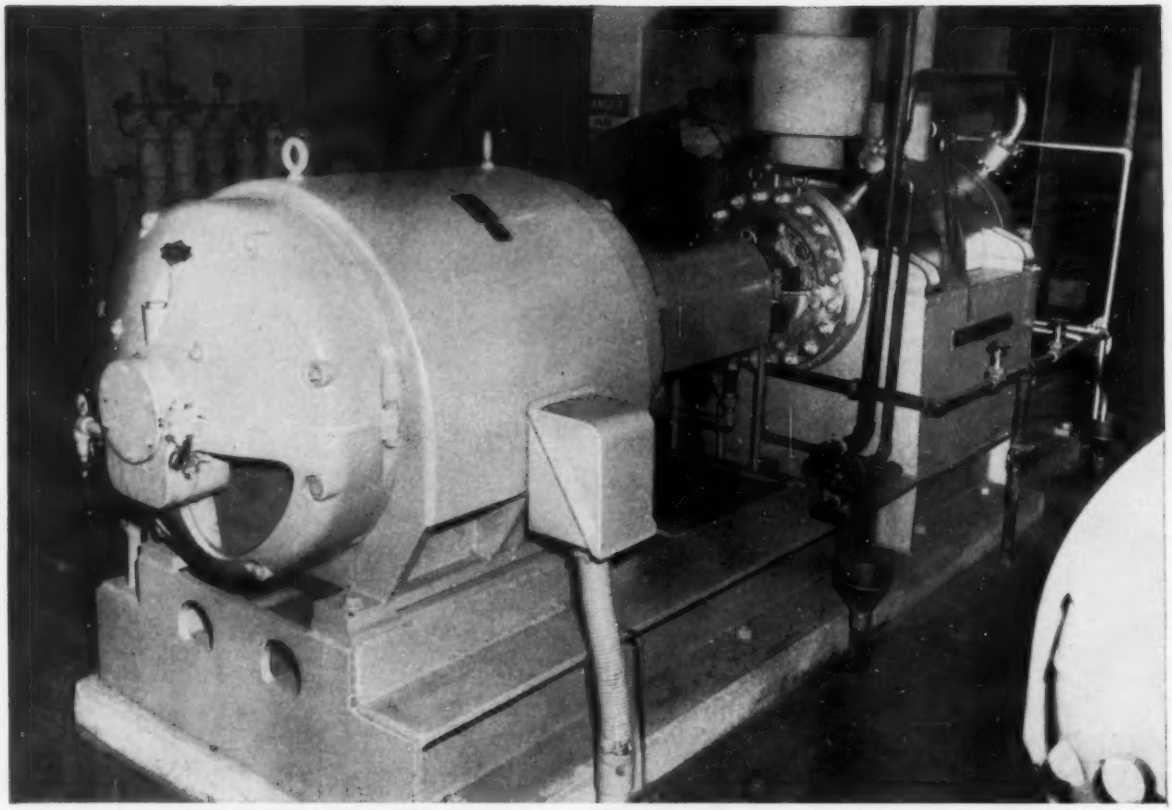


Cross-section of 1,000,000 lb per hr reheat-type steam generator for 125,000 kw turbine generator Unit 4. Operating conditions: 1750 psig, 1005 F, reheat 1005 F. Fuel is pulverized anthracite and bituminous coal.

One of the Foster Wheeler ball mills, that pulverizes a mixture of anthracite and bituminous coal at the rate of approximately 21 tons per hr. Classifier with preheated-air inlet duct is in foreground.



Feeders and exhausters on the firing floor at Sunbury. These feeders are of the rotating table type, regulating the flow of anthracite and bituminous coal to ball-mill pulverizers.



"Here is a 1000 hp, 3600 rpm E-M Induction Motor," says Pete Powerhouse, E-M auxiliary drive specialist, "driving a feedwater pump for a large utility. This motor can take it. We use Kolene-processed bearings, the most rugged and dependable type you can specify for tough 2-pole motor service."

Pete Powerhouse says...

"Dependable Service

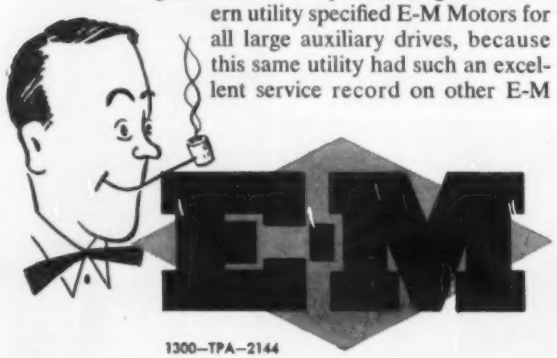
SOLD THESE POWER PLANT MOTORS"

● "I'm Pete Powerhouse, E-M auxiliary drive specialist. My business is motors in the powerhouse class, extra rugged for the gruelling demands of utility operations.

"I was glad to see recently that a large midwestern utility specified E-M Motors for all large auxiliary drives, because this same utility had such an excellent service record on other E-M Motors in their various plants.

"We consider extra dependability like this a trademark of E-M Motors. We at E-M have over 40 years of experience in intensive design and careful construction of large motors.

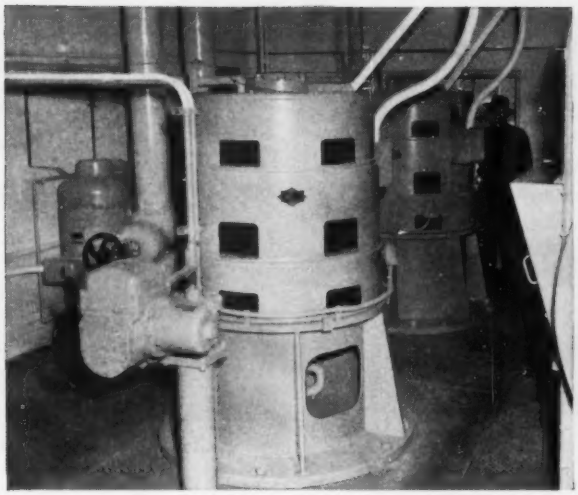
"Are you considering auxiliary drives? Ask your nearest E-M sales engineer for data, or write us at the factory for E-M Publications 189 and 214. They talk about auxiliary drive motors in detail."

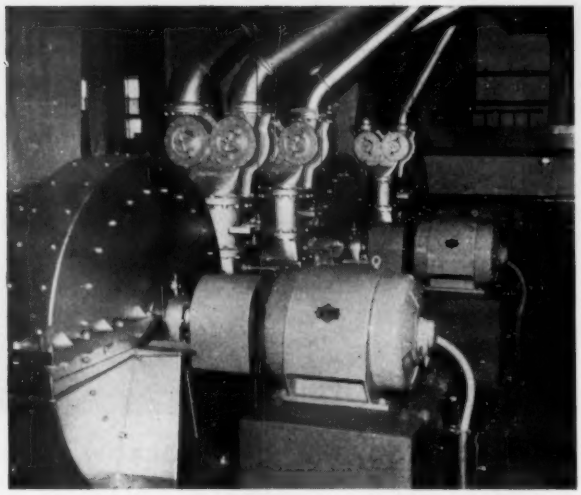


ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

1300—TPA—2144



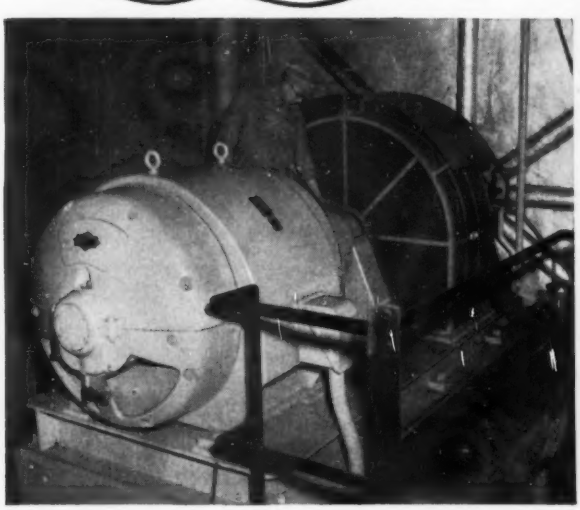


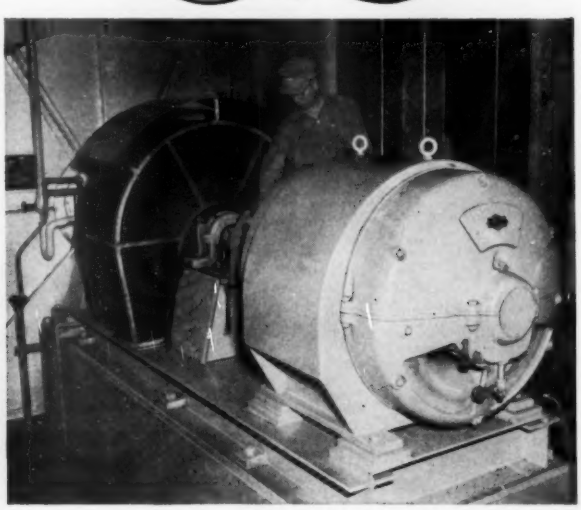
"Pete Powerhouse again. Here are two 150 hp, 495 rpm E-M Induction Motors driving vertical circulating pumps for this utility. Sectionalized frame construction of our Vertical Motors lets you get at core, coils, rotor and bearings in four easy steps. Routine care and maintenance is quick and convenient."

"These three coal pulverizers are driven by three 250 hp, 900 rpm E-M Induction Motors. Extra protection against moisture penetration, high humidity, fumes and harmful dusts is a must on these important drives. We use "Powerhouse" Insulation Treatment to give this vital protection."

"Here's a combination that's hard to beat for driving induced draft fans . . . a 700 hp, 885 rpm E-M Induction Motor and an adjustable-speed E-M Magnetic Drive. Heavy steel E-M Motor frames and enclosures are extra rigid, and pleasing in appearance, with no excessive weight."

"One more to show you. This forced draft fan is driven by a 450 hp, 1180 rpm E-M Induction Motor with an E-M Magnetic Drive to adjust speed. E-M cage construction is practically indestructible. And rugged E-M rotors are balanced precisely for vibration-free operation!"





BUILT FOR TODAY AND TOMORROW Located in the heart of a growing industrial and residential area, this central station has installed an "expandable" S-A conveying system. A good example of how S-A engineering can plan for changing needs, it is designed for lowest cost coal handling now and for continued economical operation when expanded to handle three times the present 200 tons per hour. Handling costs will stay low at all volumes!

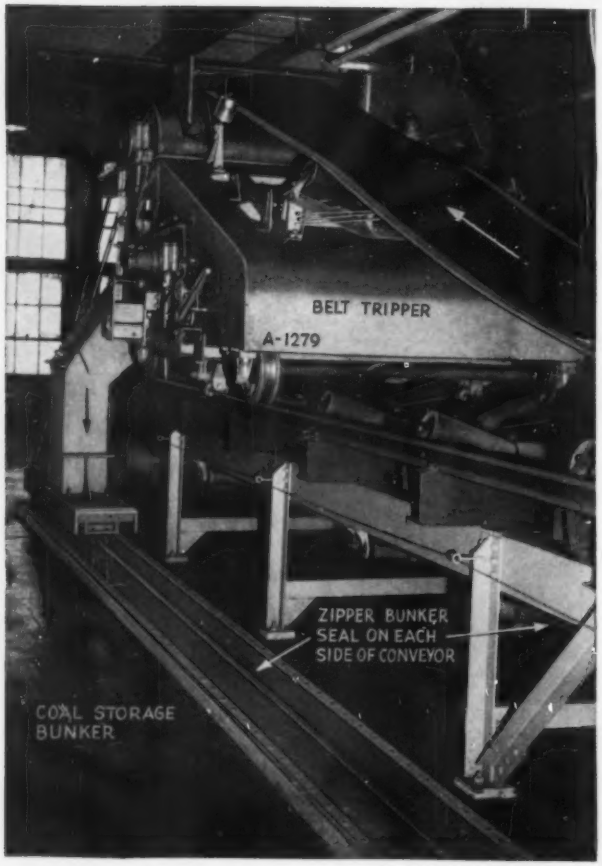
Engineered Conveying Systems REDUCE COAL HANDLING COSTS

The Stephens-Adamson coal conveying systems shown here, while different in components, design and layout, have one characteristic in common. They were all engineered to individual plant needs —to insure coal handling at low cost per ton. This economy is reflected in lower steam costs.

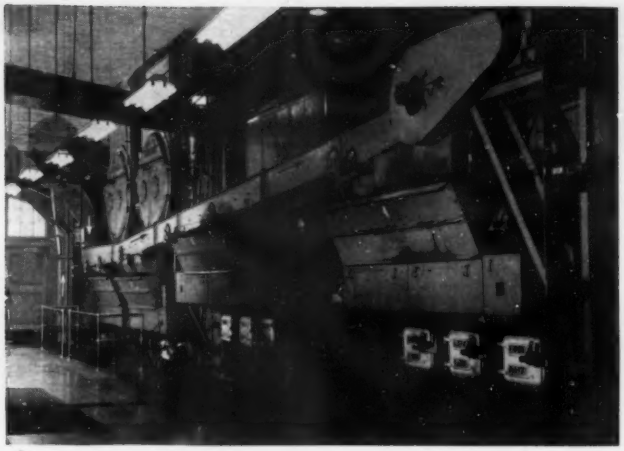
"Tailoring" to particular requirements is comparatively simple for S-A engineers. They draw upon a complete line that includes every kind of equipment for handling coal. They are backed by over half a century of experience in solving literally hundreds of different coal handling problems.

This combination of complete equipment, plus the detailed experience and "know-how", can be invaluable when improvement and modernization of your coal handling facilities is under consideration.

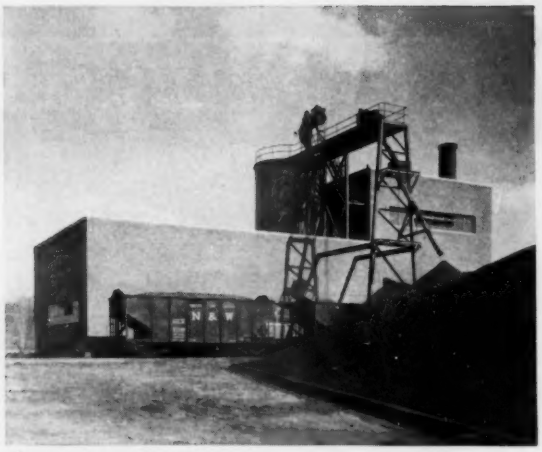
Write and we'll arrange a free survey—without obligation, of course.



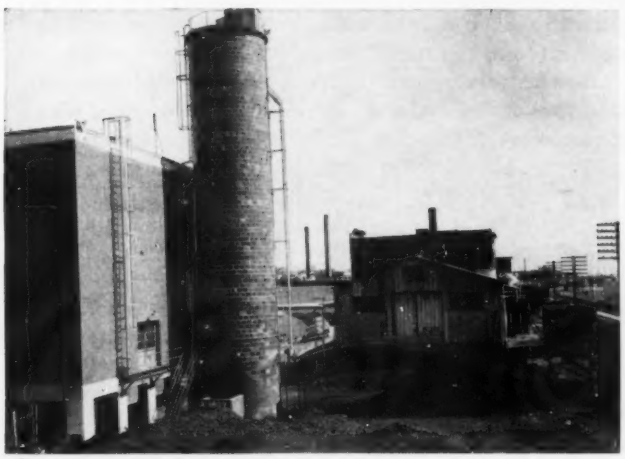
COAL ZIPPED-IN S-A patented Zipper bunker seal and belt tripper is part of new S-A coal handling system recently installed at a central station in Ohio. The seal consists of two strips of rubber with meshing teeth opened or closed by rollers mounted on the discharge spouts of tripper. Works like a slide fastener and keeps dust to a minimum inside the station.



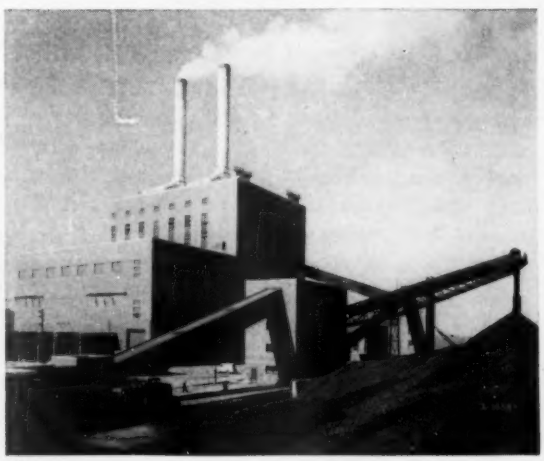
LESS LABOR COST — AND NO DUST Automatic, dustless coal handling made possible by S-A REDLER Conveyors is playing a major role in cutting weekly labor costs from $606 to $242 for this Maine textile mill. That amounts to a saving of $19,000 per year. REDLER units also have provided the layout flexibility required to meet difficult location problems existing in the plant.



EFFICIENT HANDLING IN SMALL SPACE This S-A REDLER conveying system at a municipal station in Virginia, moves 30 tons of coal per hour to either live storage above stokers or to outside stock pile. The system illustrates S-A design and use of REDLER units to save space, seal in coal dust and operate with minimum maintenance. From track side to stokers, S-A conveying systems can be engineered for any coal handling or distribution job.



SAVES $90,000 A YEAR Modernization of power plant with new boilers and controls and the installation of an engineered S-A conveying system for coal has enabled this North Carolina bleachery and finishing works to slash operating costs. Storage silo at left is filled by S-A REDLER Conveyor. Another REDLER carries coal to stoker hopper—without dust or high maintenance costs—while S-A Swivel piler stock piles overflow from silo.



750 TONS PER HOUR That's the capacity of the S-A belt conveying system at this Great Lakes station. Efficient arrangement of coal handling system which S-A engineers helped design permits coal stockpiling when bunkers in plant are full. Stocking-out conveyor at right is equipped with a motor controlled, telescoping spout. A similar plant operated by the same company is also S-A equipped.

SINCE 1901 S-A STEPHENS-ADAMSON MFG. CO.

STEPHENS-ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois • Los Angeles, Calif. • Belleville, Ontario

Engineering Division

Specialists in the design and manufacture of all types of bulk materials conveying systems.

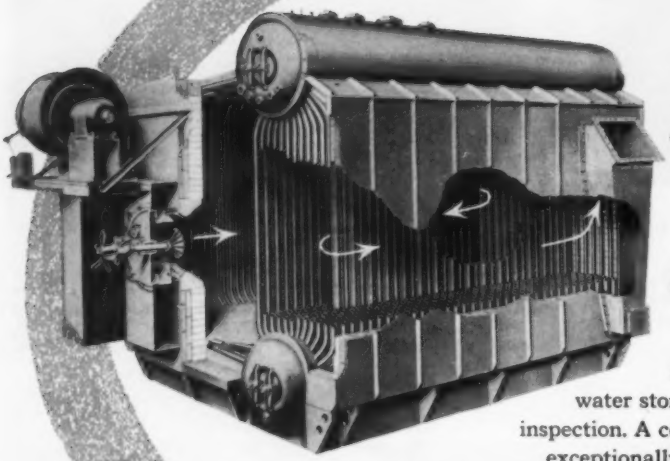
Standard Products Division

A complete line of conveyor accessories including centrifugal loaders—car pullers—bin level controls—etc.

SealMaster Division

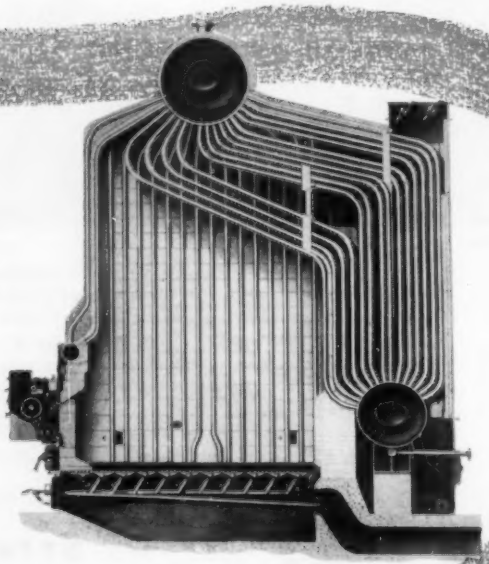
A complete line of industrial ball bearing units available in both standard and special housings.

STANDARD BOILERS THAT



C-E Package Boiler, Type VP

This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour . . . for operating pressures up to 500 psi . . . for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum — 30-inch diameter — permits a simple, symmetrical tube arrangement . . . greater water storage capacity . . . easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption. The VP is enclosed in a reinforced, gastight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.



C-E Vertical-Unit Boiler, Type VU-10

The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour . . . for operating pressures up to 475 psi . . . superheat to 200 F in 20,000-60,000 lb range . . . for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit — boiler, furnace setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

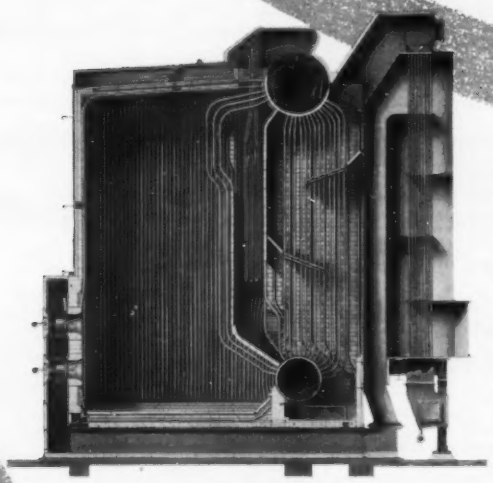
BOILERS, FUEL BURNING AND RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS AND

SET INDUSTRY STANDARDS

Whatever your needs for steam may be, in the complete C-E line of fuel burning and steam generating equipment, you will find a type and size just right for your plant.

In the moderate capacity range, for example – that is, from 4,000 to 120,000 pounds of steam per hour – the three *completely standardized* C-E Boilers shown here offer advantages of economy and over-all performance that make them standout values in their respective fields of application.

These C-E Boilers are manufactured for the highest standards of performance, under a wide range of fuel requirements and operating conditions. Yet, because they are so fully standardized, their cost is well within the reach of the industrial budget.



C-E Vertical-Unit Boiler, Type VU-55

The VU-55 Boiler is available in six sizes from 50,000 to 120,000 pounds of steam per hour . . . for operating pressures of 250 psi or 500 psi in each size . . . with superheat and heat recovery equipment if desired . . . for liquid or gaseous fuels. Like the VU-10, this boiler is of symmetrical design, each transverse section being identical with every other section. Thus the gas temperature entering the boiler bank is constant across the full width of the unit. No outside supporting steel is needed, since the boiler is bottom-supported. The basic design for the VU-55 was originated by Combustion in 1925 and has achieved wide acceptance among steam-power engineers everywhere. Its narrow, high furnace . . . integral design of boiler and preheater . . . absence of exterior ductwork . . . and the compactness resulting from modern, coordinated design – all help the VU-55 reach a standard of economic performance closely approaching that obtained in large central power stations.

Other C-E Industrial Boilers

In addition to the standard boilers shown here, the Combustion line includes many other 2-drum designs available for capacities up to 350,000 pounds of steam per hour, which can be designed to burn any commercially available fuel. These units are available for use with pressures up to 1375 psi and steam temperatures as high as 960 F. They may incorporate heat recovery equipment of any type, and can be arranged for difficult space conditions. So – whatever your steam needs – call Combustion for details on the complete line of C-E Industrial Boilers.

B-767

COMBUSTION ENGINEERING

C-E

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

FLASH DRYING SYSTEMS · PRESSURE VESSELS · AUTOMATIC WATER HEATERS · SOIL PIPE

Real economy in condenser tubes is achieved when a sound balance is achieved between first cost, long-range operating efficiency and maintenance expense.

In applications where contaminated salt or fresh water and high velocities are encountered, Bridgeport Duronze IV (Alloy 53) Condenser Tubes meet these requirements. Although first cost is slightly more, the improved performance, better corrosion resistance and longer tube life, prove the *Real* economy of Bridgeport Duronze IV.

Bridgeport's Technical Service will be happy to tell you about the economies of Duronze IV, or recommend one of the many other Bridgeport Condenser Tube Alloys best suited for your particular application. Call your local Bridgeport office for immediate service.

Want to receive our monthly Copper Alloy Bulletin regularly? Ask us to add your name to our mailing list. The Bulletin contains news about the latest developments in the condenser tube field and useful design and maintenance helps.

BRIDGEPORT BRASS COMPANY ◆ BRIDGEPORT, CONNECTICUT

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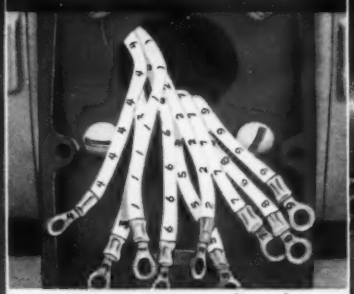
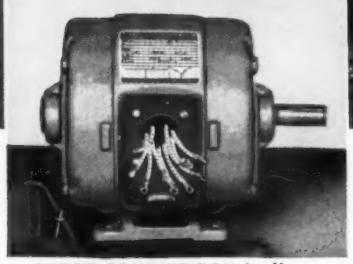
TRI 55 CLAD THE LEADER IN MODERN MOTOR DESIGN

PERMA-NUMBERED LEADS



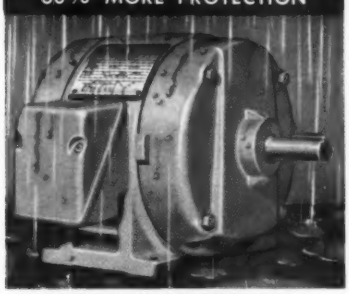
EASIER TO SERVICE, clipped or taped terminals always can be read. You save hooking-up time.

EASY ACCESS CONDUIT BOX



LARGE CONDUIT BOX is diagonally split—gives you ample knuckle room for easier wiring.

60% MORE PROTECTION



MORE FULLY PROTECTED motor achieved through redesign of cast iron frame and end shields.

LONGER MOTOR LIFE

NEW BEARING SYSTEM means the G-E motor runs longer without relubrication than any other.

Now, easier installation, less maintenance...

G.E.'s new TRI 55 CLAD motor—you can install it and forget it!

REG. U.S. PAT. OFF.

The all-new General Electric Tri/Clad '55' motor is specially engineered to reduce your installation costs . . . and run longer, without attention, than ordinary motors. This new motor gives you 60% more physical protection plus longer electrical life. In addition, a bearing system designed to use the most modern greases means you will not have to regrease the Tri/Clad '55' for years.

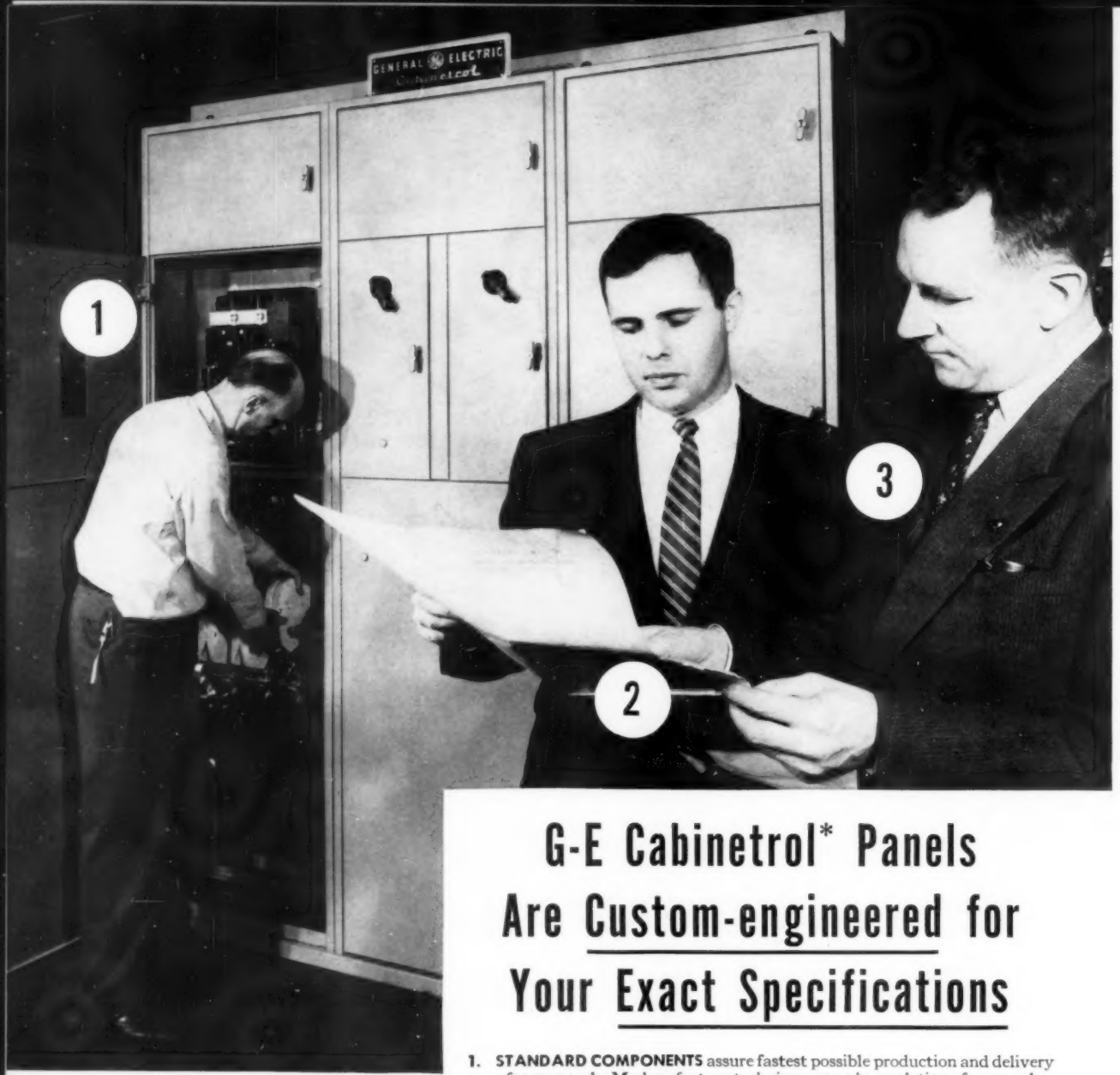
You save with the new Tri/Clad '55' because wiring is easier and faster. The large, diagonally split conduit box gives you plenty of knuckle room. Leads are perma-numbered . . . you can always identify them instantly.

The new Tri/Clad '55' also brings you important handling, storing and installing economies. Better use of space within the frame means a 30% reduction in size and weight in some ratings. Yet active materials (magnetic steel and copper) are not sacrificed.

General Electric Tri/Clad '55' motors are now available in many ratings. The complete line of 1 to 30 hp a-c motors will be available soon. For full details contact your G-E Apparatus Sales Office or G-E Motor Supplier today. Write for Tri/Clad '55' bulletins GEA-6013—Dripproof motors, GEA-6012—Enclosed motors, GEA-6027—Gear-motors. General Electric Company, Section 648-7, Schenectady 5, N. Y.

Progress is our most important product

GENERAL ELECTRIC



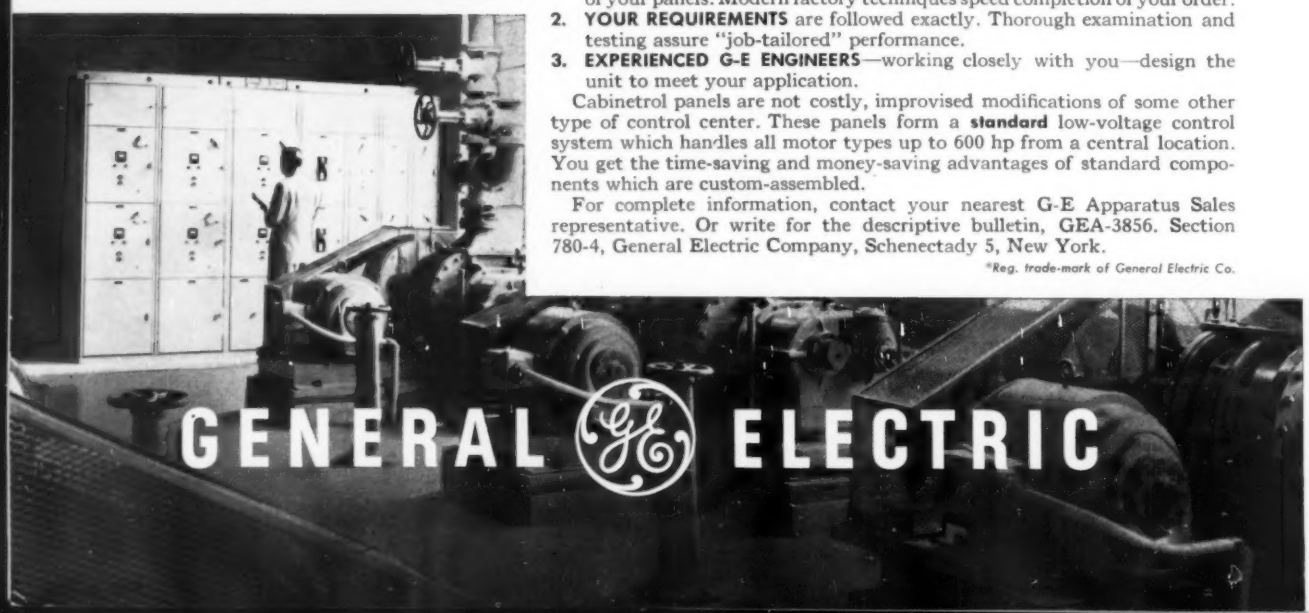
G-E Cabinetrol* Panels Are Custom-engineered for Your Exact Specifications

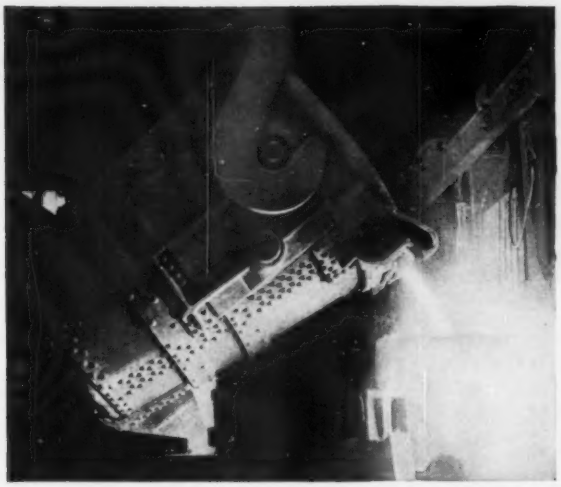
1. **STANDARD COMPONENTS** assure fastest possible production and delivery of your panels. Modern factory techniques speed completion of your order.
2. **YOUR REQUIREMENTS** are followed exactly. Thorough examination and testing assure "job-tailored" performance.
3. **EXPERIENCED G-E ENGINEERS**—working closely with you—design the unit to meet your application.

Cabinetrol panels are not costly, improvised modifications of some other type of control center. These panels form a **standard** low-voltage control system which handles all motor types up to 600 hp from a central location. You get the time-saving and money-saving advantages of standard components which are custom-assembled.

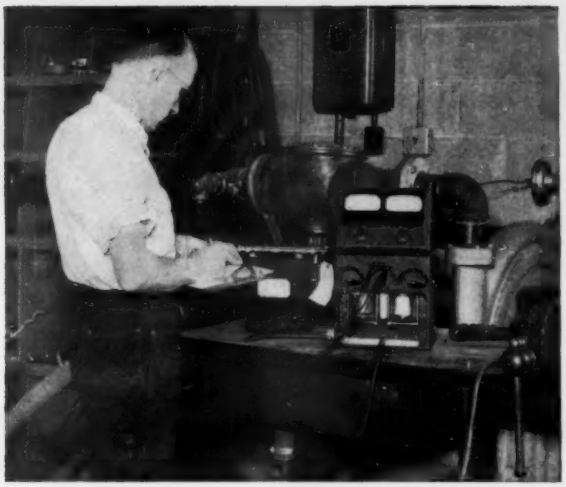
For complete information, contact your nearest G-E Apparatus Sales representative. Or write for the descriptive bulletin, GEA-3856. Section 780-4, General Electric Company, Schenectady 5, New York.

*Reg. trade-mark of General Electric Co.





STEEL OUTPUT INCREASED BY 110 TONS PER DAY REPORTS STEEL PRODUCER: Tap-to-tap time reduced from 18 to 12 hours . . . Fuel cut 46% per ton produced . . . Tonnage up 50% daily! That's the job Cities Service Heat Prover helped perform for one of the largest steel producers.



"COMPLETED 30 HOUR TEST IN JUST 6 HOURS!" "We completed what normally would have been a 30 hour test in just 6 hours," writes the Eclipse Fuel Engineering Co. of Rockford, Ill. "We found the Heat Prover equally exact, perhaps more exact than standard commercial testing equipment."

INDUSTRY REPORTS ON FURNACE OPERATION:

PRODUCTION UP, COSTS DOWN WITH CITIES SERVICE HEAT PROVER

THE CITIES SERVICE HEAT PROVER . . . Not an instrument that you buy . . . but a service we supply . . . FREE!

Shown above are just two of the many outstanding accounts of the Heat Prover's impressive accomplishments. Wherever a furnace operation is involved, the Heat Prover can help increase productivity by providing:

- **Rapid, continuous sampling**
- **Simultaneous reading of oxygen and combustibles**
- **Direct measurement of oxygen and combustibles**
- **Easy portability**
- **Free maintenance and re-calibration service**

Learn how the Heat Prover, supplied and maintained free by Cities Service, can benefit you. For details, contact your nearest Cities Service office or write: Cities Service Oil Company, Sixty Wall Tower, New York City 5, N. Y.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

Only Brown flow meters offer you these profitable "*plus*" *values*

- ***16 different types*** of basic instrument systems . . . a flow meter for every fluid, every pressure, every operating requirement. *You're sure to find the most profitable meter for your specific application.*

- ***Nearby service facilities.*** There's a Honeywell service center as near to you as your phone. Service by factory-trained specialists is prompt, competent and economical. *You're sure to get maintenance and start-up service without delay.*

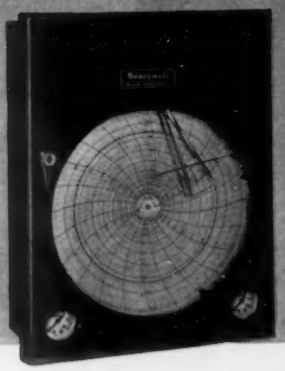
- ***27 years of experience*** in flow metering development and application work. *You're sure to get specialized engineering on your flow metering problem.*

- ***Nationwide field organization.*** Brown flow metering consultation is available from experts in more than 90 field offices, located near every major production center. *You're sure to have application engineering on hand where and when you need it.*

Linear scale meters—mechanical or electrical types, all control forms.

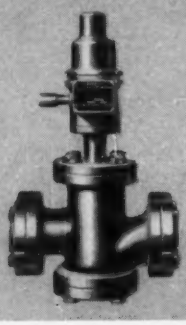
Square root scale meters—mechanical, or electrical or pneumatic transmission . . . all control forms.

Portable meters—versatility, for spot checks of flow values not continuously recorded.

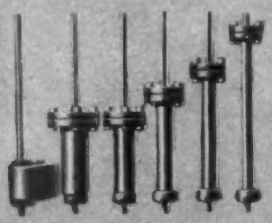


Low pressure meters—either electrical or mechanical type, for air or gas flow.

Differential Converter—mercury-less pneumatic flow transmitter with infinitely adjustable range.



Area Type Meters for measuring flow of viscous fluids . . . electrical transmission.



Interchangeable range tubes typify rangeability of all Brown flow meters.

NOTE:

Tel-O-Set miniature instruments and *ElectroniK* indicators, recorders and controllers are available for use with all flow transmitters.

a flow meter for every fluid...

every application (all available with electronic integration)

IN PERFORMANCE, too, Brown flow meters provide you unsurpassed precision . . . reliability . . . convenience . . . with minimum maintenance requirements. In every way, you'll find it pays to select your flow meters from the one line that offers the most value.

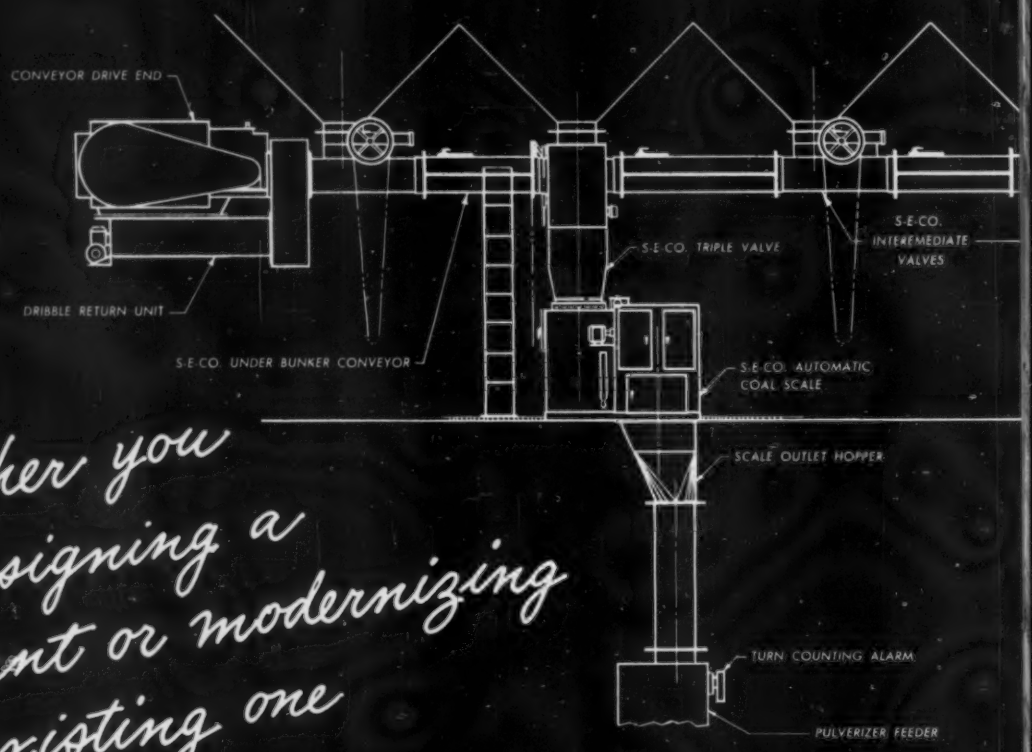
Your nearby Honeywell sales engineer will be glad to discuss your specific flow application . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

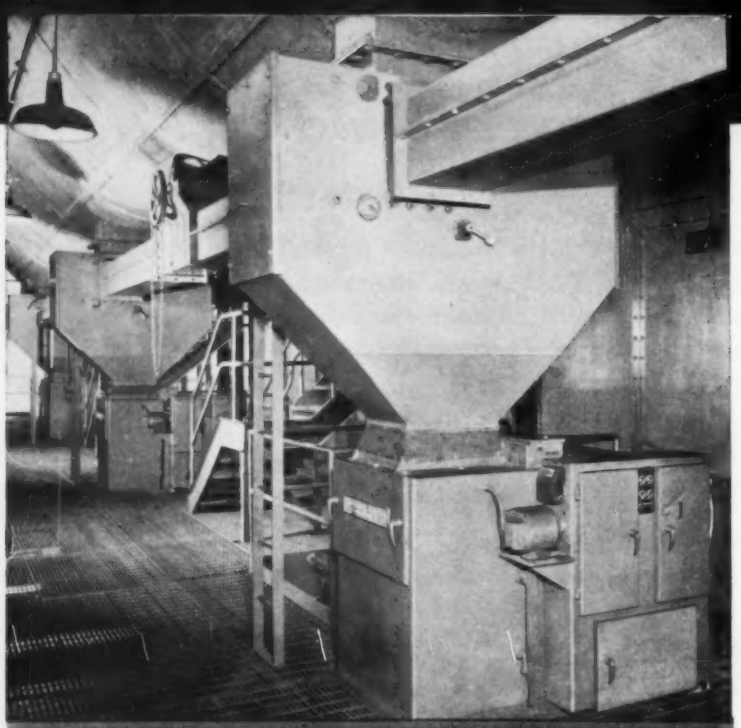
● **REFERENCE DATA:** Write for new Catalog 2320, "Flow Meters, Indicating, Recording, Integrating, Controlling."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls



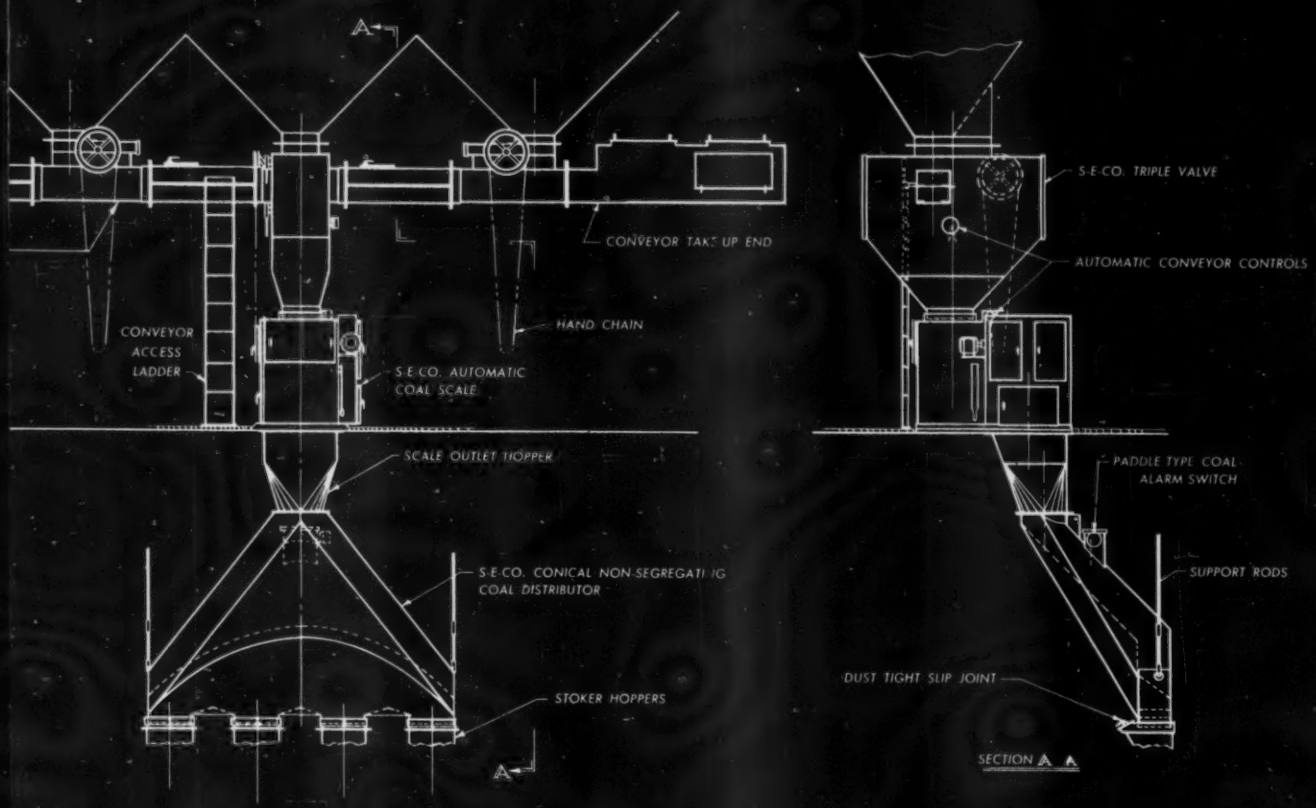
Whether you are designing a new plant or modernizing an existing one



S-E-Co. Under-Bunker Installation at J. E. Greenebaum Tanning Company, Milwaukee, Wisconsin.

STOCK EQUIPMENT COMPANY specializes in the design and manufacture of *Bunker to Pulverizer and Bunker to Stoker Installations* of the highest quality. Each job is carefully studied to provide an arrangement that will offer long life, reliable coal flow, and accurate weights of coal burned. Where stokers are involved, the arrangements also will prevent coal segregation.

Each S-E-Co. Job actually amounts to a custom built installation, using standard, jig-built components. These standard items include the S-E-Co. Coal Valve, Automatic Under-Bunker Conveyor, Paddle Type and Turn Counting Type Coal Alarms, Automatic Coal Scale and the S-E-Co. CONICAL Non-Segregating Coal Distributor.



THERE ARE SIX GOOD REASONS WHY YOUR LAYOUT SHOULD INCLUDE A S-E-CO. AUTOMATIC UNDER-BUNKER CONVEYOR

1. For automatic, dust-tight delivering and weighing of coal to any boiler from any bunker outlet.

2. Coal that would otherwise be dead between boilers is made available to any boiler.

3. Coal in bunker in front of boilers not on line is made available to boilers that are operating.

4. In providing means to move coal from any bunker outlet, the conveyor helps prevent bunker fires. Also helps prevent the coal from lying so long that it becomes set.

5. If coal in bunker catches fire, the conveyor can deliver it to all boilers in operation or discharge it from building through emergency outlet.

6. The S-E-Co. Under-Bunker Conveyor is of the highest quality — proven by many installations which have operated for many years.

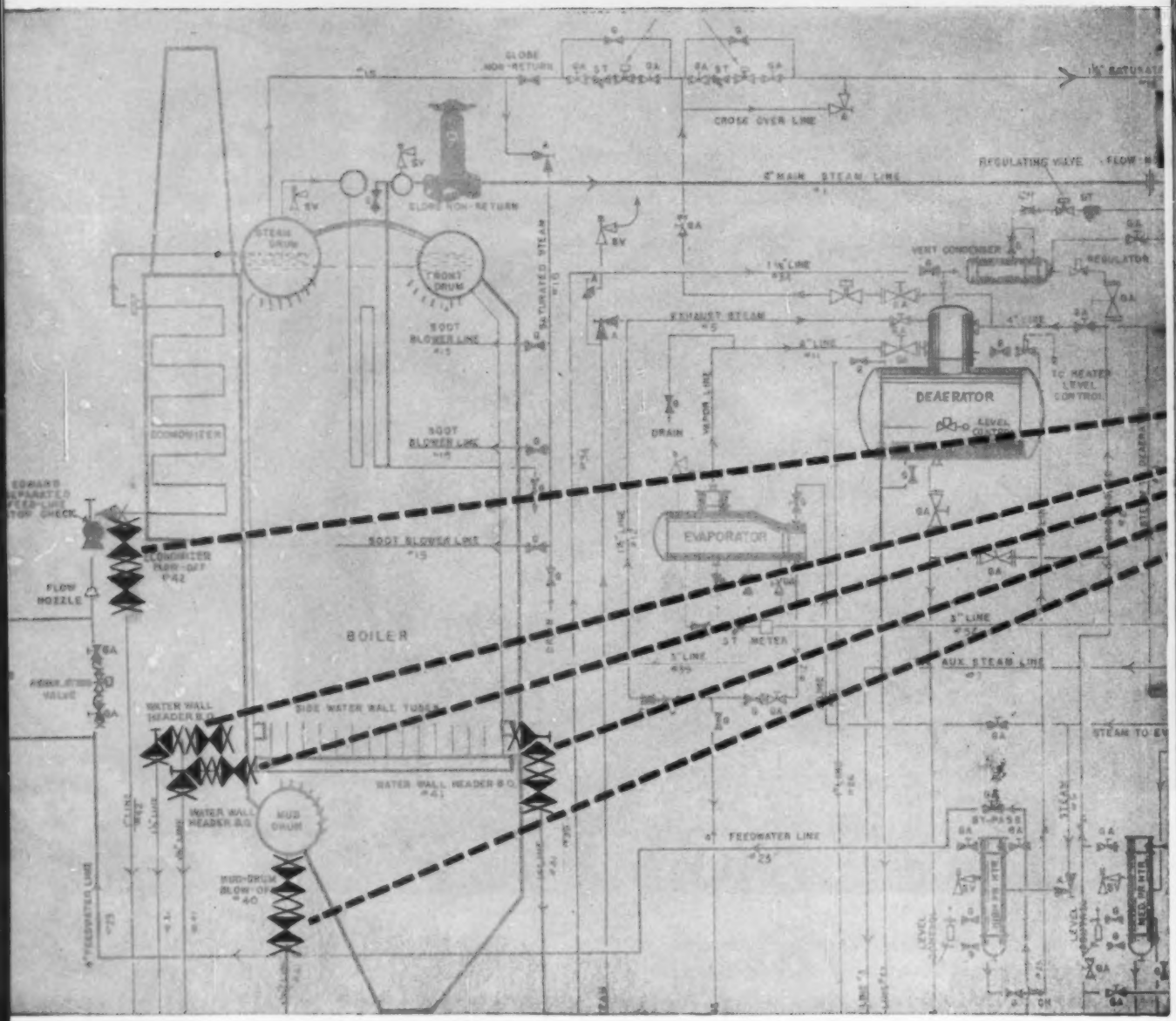
In the design of new plants, the above points allow the use of a more efficient bunker which can lower the overall building height without sacrificing any amount of coal available to the boilers.

In the modernization and expansion of existing plants, the Under-Bunker Conveyor provides a feasible means of using existing long, shallow bunkers to reliably feed new boilers which have replaced a number of much smaller boiler units.

For help with your layout, contact a local representative or write direct to:

STOCK EQUIPMENT COMPANY • CLEVELAND 15, OHIO

What you should know about



In the nearly 50 years since Edward designed and built the first steel blow-off valves, experience and research have revealed many facts about them. Here are some of the most important.

OPERATIONAL POINTERS

. . . that will reduce maintenance and extend life of your blow-off valves:

1 During blow-down periods, open valve nearer boiler wide, first; then, slowly open other valve. In shutting down, close second valve first; then valve nearer boiler. This procedure places greatest wear on blowing valve and insures a tight valve next to boiler. Should blowing valve show wear, erosion, etc., it can be repaired or replaced without a boiler shut-down.

2 Open blowing valve slowly to prevent damaging shock to piping. (Edward blow-off valves are slow-opening valves that operate at normal hand-wheel speeds to eliminate errors by inexperienced operators.)

SELECTION IDEAS

. . . that reduce up-keep costs:

1 Always buy two valves of same type to permit interchangeability of parts. (All Edward blow-off valves sets have interchangeable parts.)

2 Pick blow-off valves with the packing far removed from the high temperature zone. (In Edward blow-off valves packing is above a condensate cooling chamber—out of the high temperature zone.)

3 Select blow-off valves with backseats to protect and isolate packing in service. (Edward blow-off valves have line-contact backseats for positive sealing.)

4 Be certain that in the valve hookup *both* valves will stay tight. (With Edward blowing is the same design as its mate. *Both* are capable of tight shut-off.)

5 Select blow-off valves designed so that the disk *lifts* off the seat on operating instead of grinding against it. This eliminates the possibility of seat-disk galling. (Edward swivel disk construction allows disk to turn on the stem and lift vertically away from seat.)

6 Above all, avoid gadgety, involved designs. You are fundamentally interested in long, dependable service and freedom from maintenance. (Edward blow-off valves are simple in design, and have an excellent record for long, trouble-free life.)

BOILER CODE REQUIREMENTS

. . . that control blow-off valves:

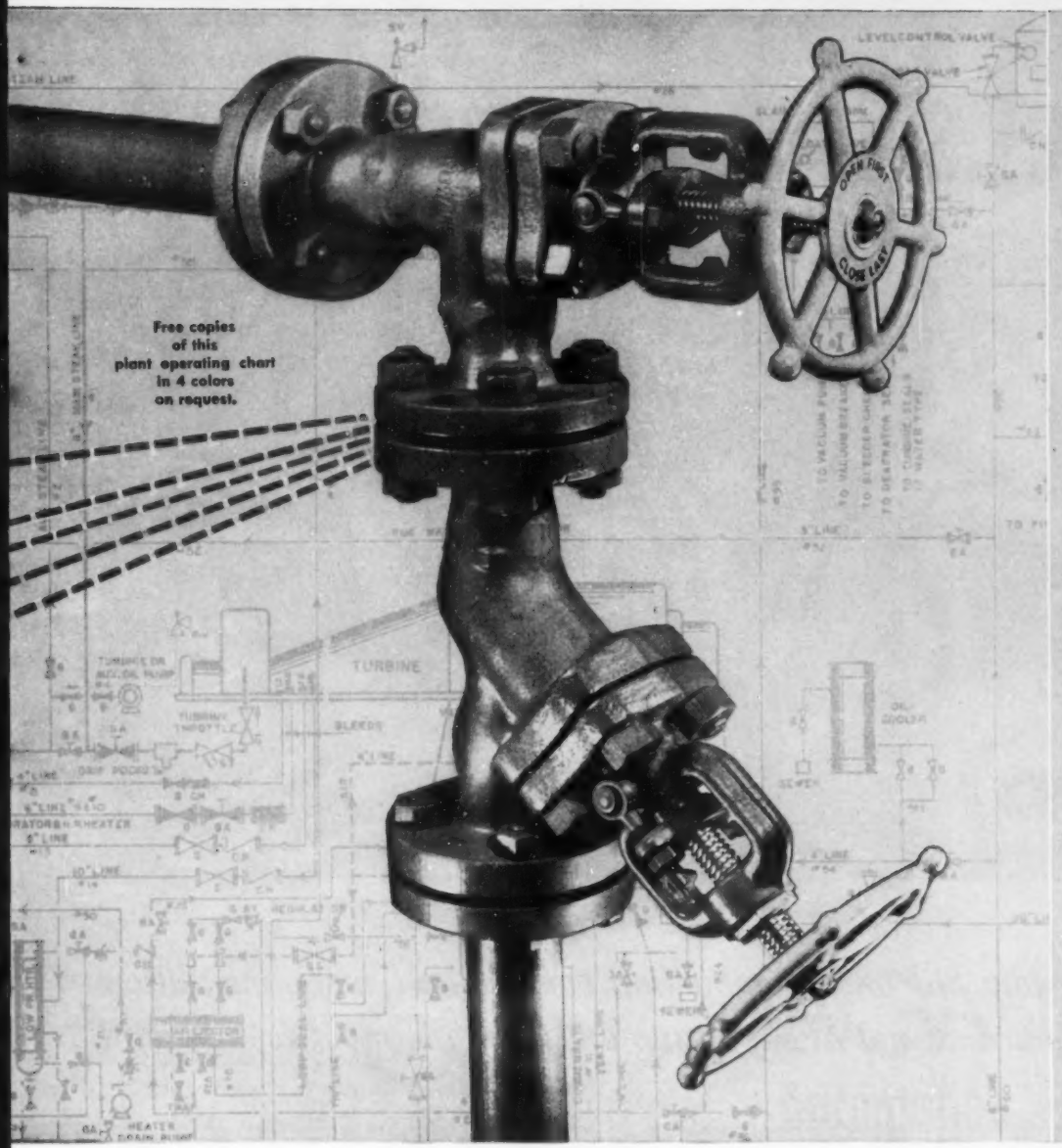
P-307

(a) A blow-off as required herein is defined as a pipe connection provided with valves through which the water in the boiler may be blown out under pressure.

P-308

(b) Minimum size for pipe and fittings shall be 1 in., and the maximum size shall be 2½ in.

BLOW-OFF VALVES*



300 lb sp

600 lb sp

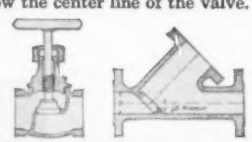
900-1500 lb sp

1500-2500 lb sp

(c) Straight-run globe valves of the ordinary type as shown in Fig. P-43A, or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used on such connections.

(d) Straightway "Y" type globe valves as shown in Fig. P-43B, or angle valves, may be used in vertical pipes, or they may be used in horizontal runs of piping provided they are so constructed or installed that the lowest edge of the opening through the seat shall be at least 25 per cent of the inside diameter below the center line of the valve.

P-43A Type of Globe Valve



P-43B Type of Straightway "Y" Globe Valve

P-310

(c) Valves and fittings from the boiler to and including the required stop valves shall be equal at least to the requirements of the American Standards for a pressure 1.25 times the maximum allowable working pressure of the boiler of 1.25 times the lowest set pressure of any safety valve on the boiler drum.

(e) For pressures over 200 psi, the valves or cocks shall be of steel construction equal at least to the requirements of the American Standard for 300 psi.

Table P-15 Maximum Allowable Boiler Pressure for Feed Line and Blow-off Line under Par. P-310

Pressure Class	100	300	400	600	900	1500	2500
Std. Facing	150	416	540	785	1120	1745	2625
Ring Joint or Welded Joint	160	515	665	950	1350	2080	3120

P-311

(a) When the allowable working pressure exceeds 100 psi, each bottom blow-off pipe shall have two slow-opening valves, or one slow-opening valve and a quick-opening valve or a cock complying with the requirements of Par. P-310. By "slow-opening" valve is meant one which requires at least five 360 deg. turns of the operating mechanism to change from full-closed to full-opening and vice-versa.

*One of a series providing condensed information on valve applications in steam power plants.

Edward Valves, Inc.
Subsidiary of ROCKWELL MANUFACTURING COMPANY
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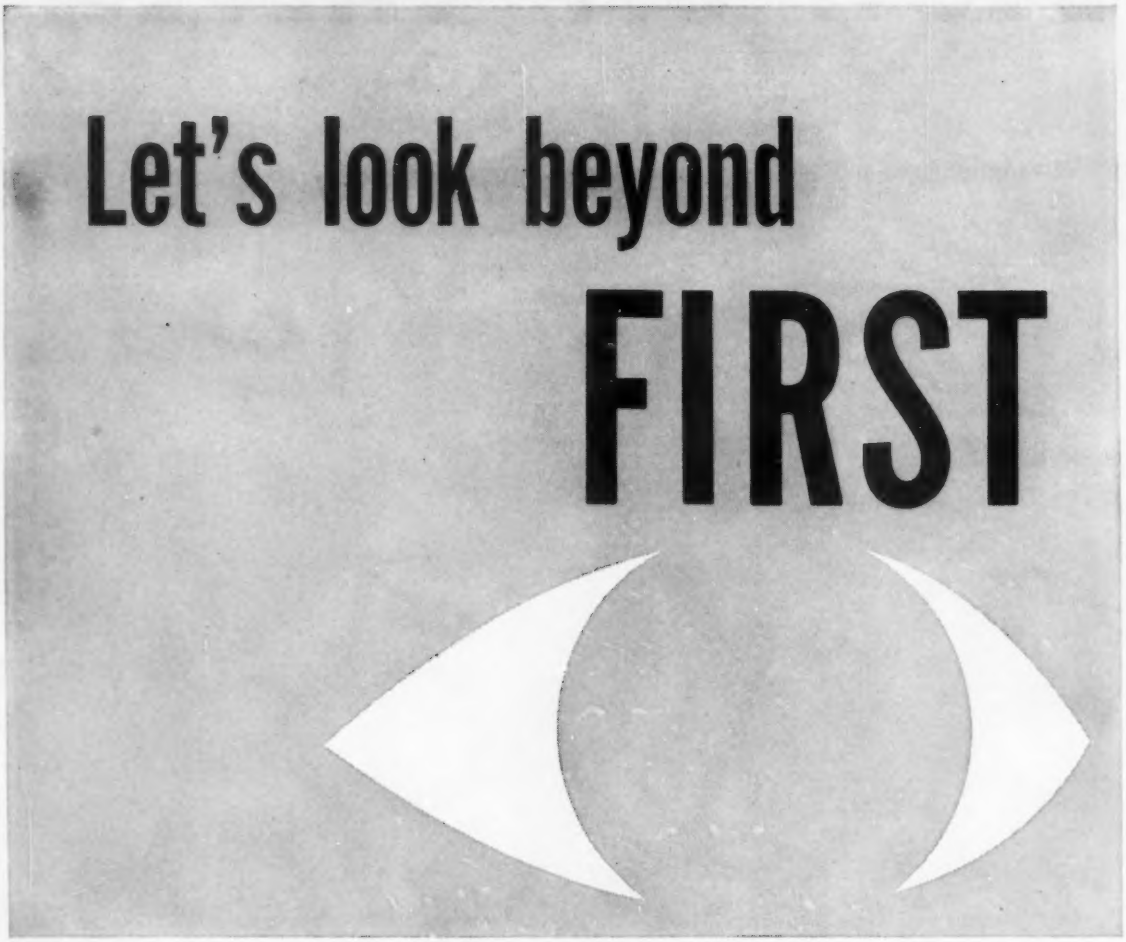
Another Product



The low bid on a combustion control and instrumentation system does not always turn out to be the most economical.

Among the factors that merit serious consideration in evaluating the overall economics of a system are the long term costs of unit replacement, maintenance and fuel.

Hagan Controls and Instruments are sturdily built and designed for continuous, trouble-free operation. As a result, Hagan systems normally outlast the boilers on which they are installed, and maintenance costs are kept at a consistently low level.

Fuel costs are by far the largest single item to consider. A 100,000 lb/hr boiler will normally consume about $8,000,000 worth of fuel during the life of the boiler. If the combustion control

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system wastes as little as 1% of the fuel, the loss amounts to $80,000, which might be two or three times the total cost of the system.

The design and construction of all components of Hagan Automatic Combustion Control systems stress durability, accuracy and ease of operation. Hagan Ring Balance Instruments provide the accurate records which enable operators to maintain top efficiencies. Truly, a Hagan System is an investment in long term economy.

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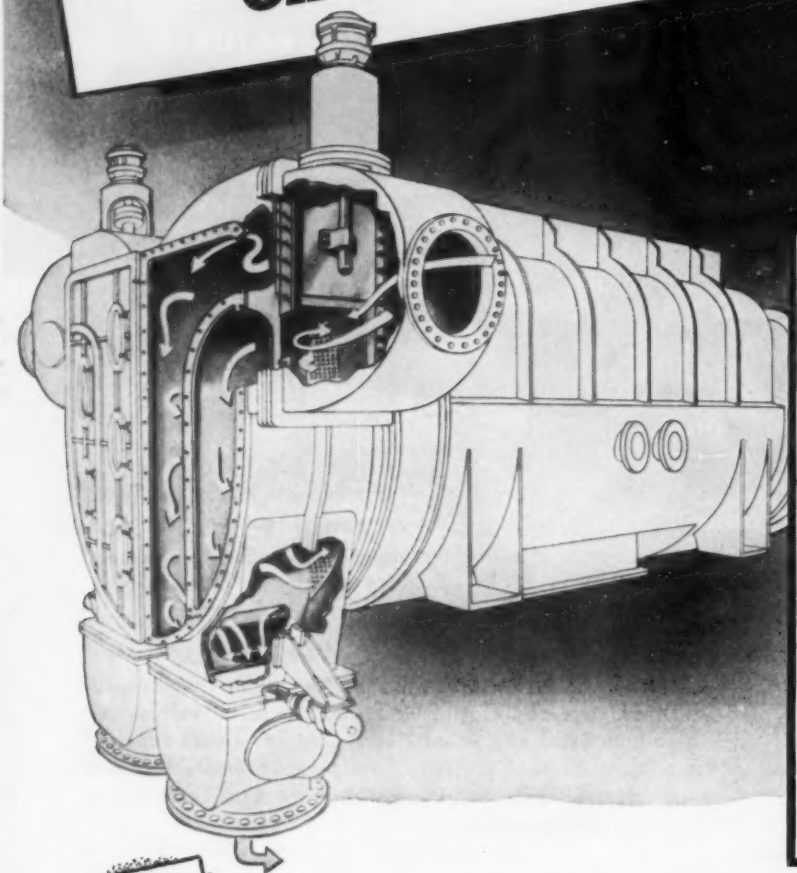

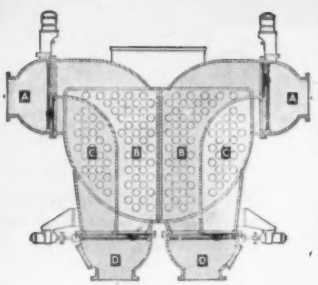

HERE IS HOW REVERSE FLOW WORKS

Reverse flow sluice gates on divided water box condensers work the same in both halves but independently of each other. Right side: normal flow. Water enters divided water box in valve chamber "A" with lower port open. It flows through pass "C" to end of condenser, back through pass "B" and out through left port of "D."

Left side: flow is reversed. Valves at inlet "A" and discharge "D" are changed to permit water to flow through "B" and back through "C" in the opposite direction and then out through the left port of "D."

1 CLEAN DEBRIS FROM CONDENSER TUBE SHEETS WITHOUT DOWNTIME OR LOSS OF VACUUM

C. H. Wheeler "Reverse Flow" Condenser design provides a powerful self-cleaning flushing force by the simple procedure of reversing the flow of water through the tubes. Electrically or hydraulically controlled sluice gates accomplish in minutes cleaning that consumes hours of downtime when removal of debris is done by hand. Power plant modernization calls for the efficiency and uninterrupted operation of C. H. Wheeler "Reverse Flow" Condensers. You don't need costly water straining apparatus. Send for latest bulletin #410.

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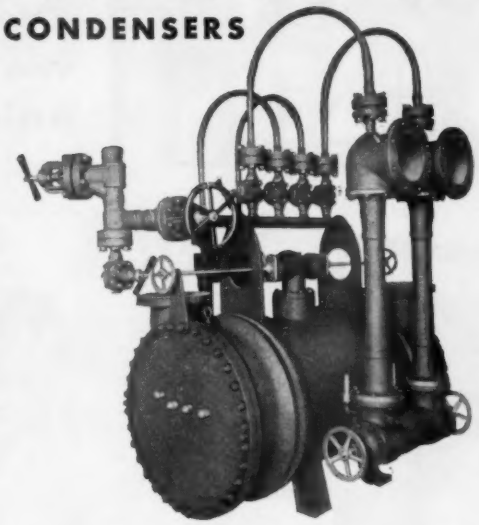

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3 WHEELER-ECONOMY CIRCULATORS HANDLE LARGER VOLUMES OF WATER AT LOWER COST

Wheeler-Economy Pumps for Condenser Cooling Water Circulation are made in horizontal double suction and vertical submerged, axial mixed flow types. These pumps are noted for reliability, the result of superior modern design and heavy duty, quality construction. They are built in all sizes to meet capacity requirements up to 200,000 GPM. Wheeler-Economy Circulating Pumps are also furnished in special metals to handle corrosive waters. The impellers are designed for satisfactory operation during all load requirements.

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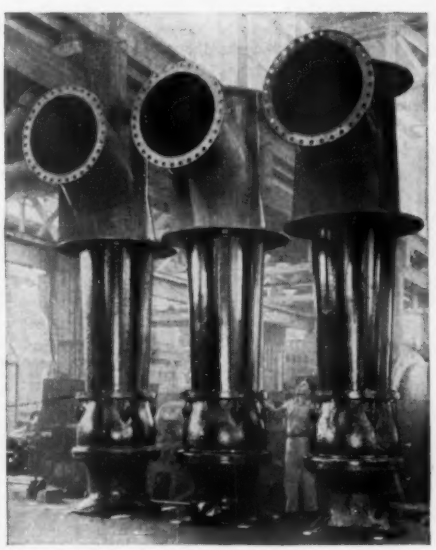

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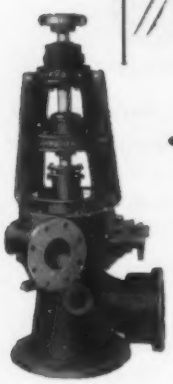

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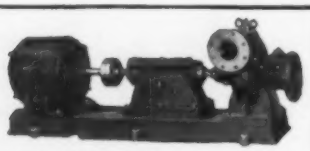

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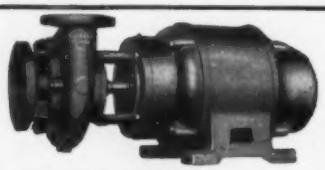

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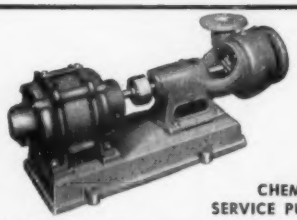

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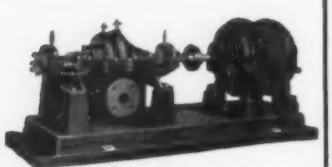

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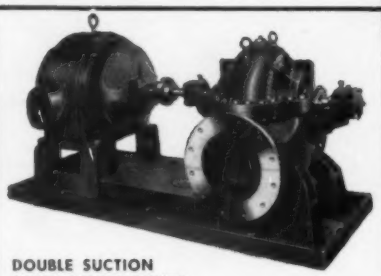

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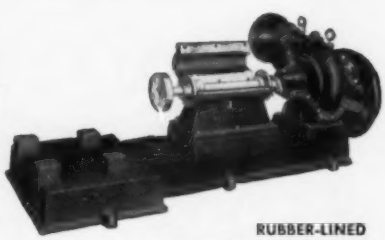

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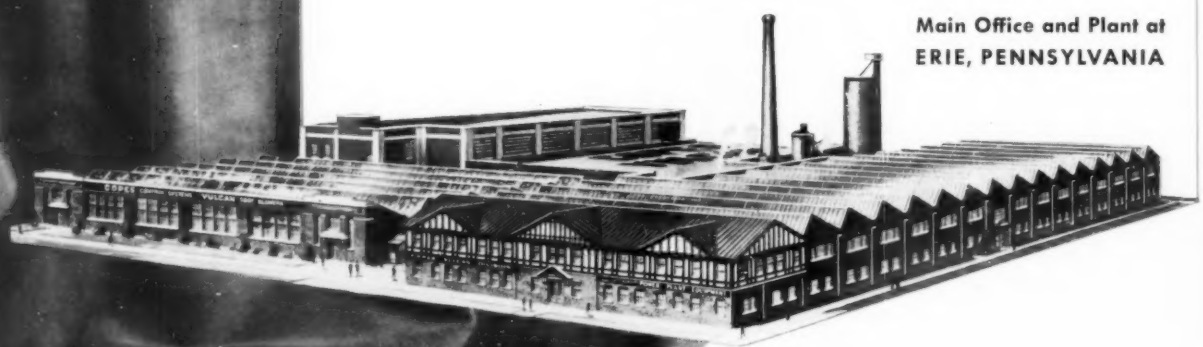

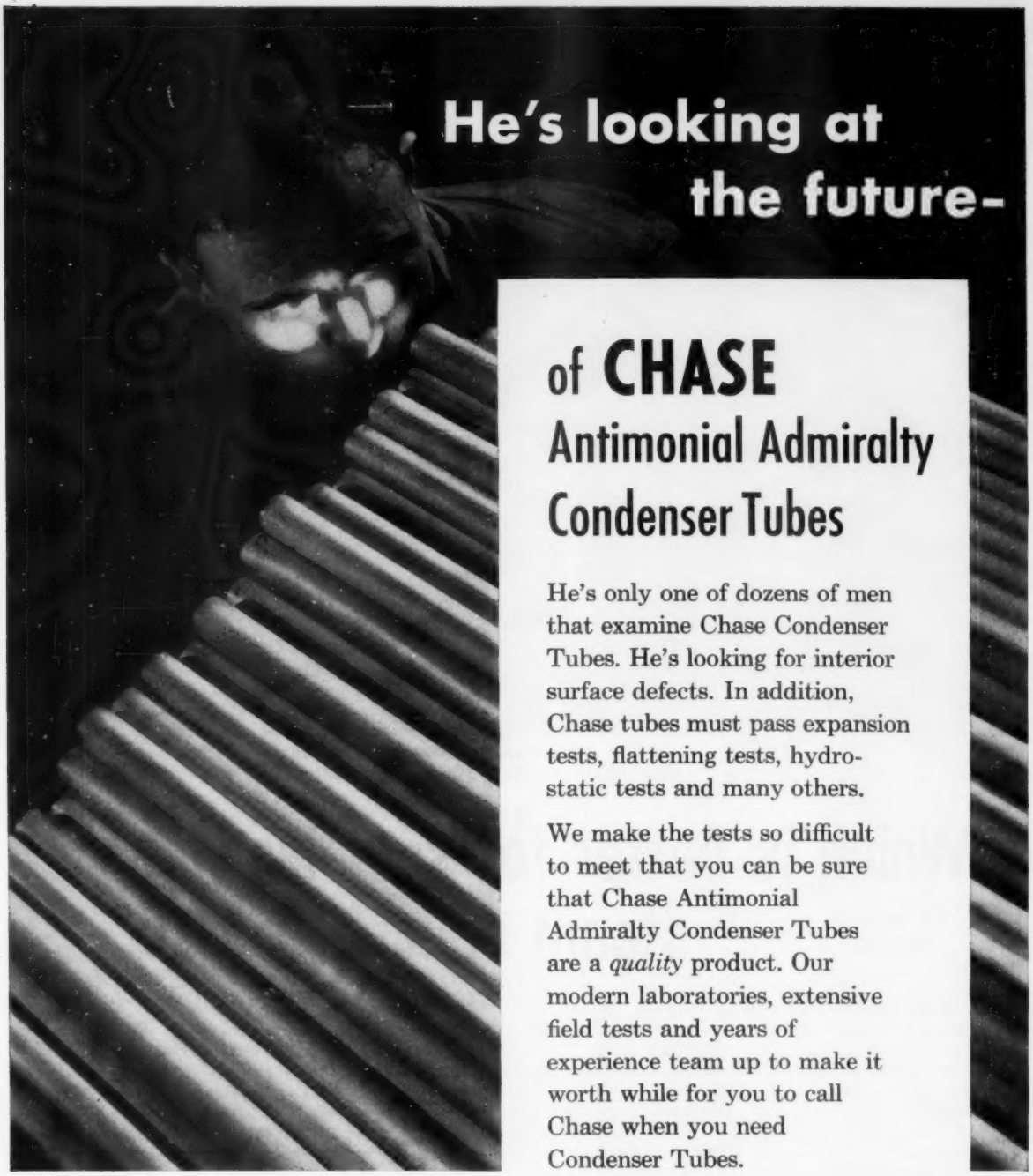

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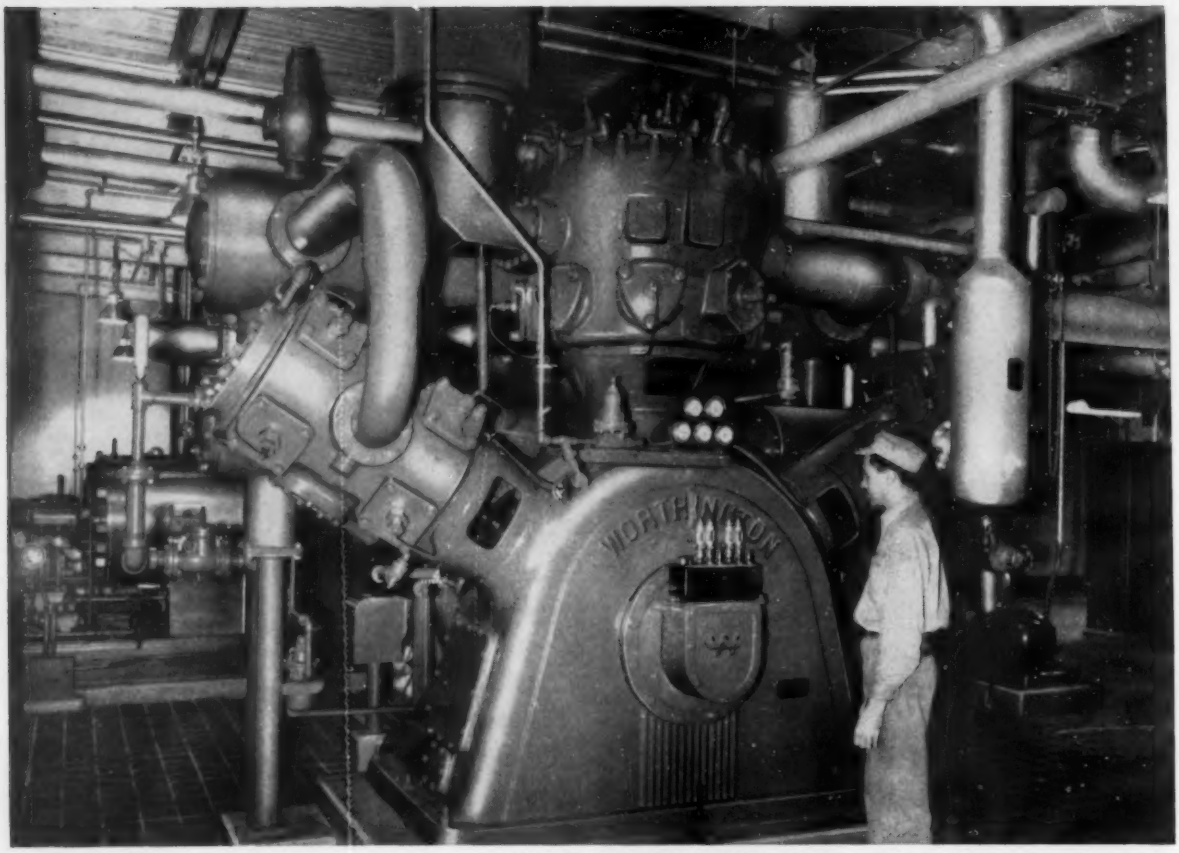

PENNSYLVANIA POWER COMPANY gets air for soot blowing from two Worthington DYC-3 air compressors at their New Castle Power Plant.

Which is better for soot blowing — steam or air?

If we asked that question 20 years ago, the answer would be steam. But today you'd be right if you said "compressed air."

Key to the success of compressed air in soot blowing was the development of simple, automatic controls. Not only can you pre-select an operation sequence for efficient cleaning, but you're sure that the cleaning operation will be complete — and carried on only at the most efficient pressure.

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Read our Bulletin L600-B14 — "Worthington Compressors for Soot Blowing". Write for it to Worthington Corporation, Water-Cooled Compressor Division, Harrison, N.J.

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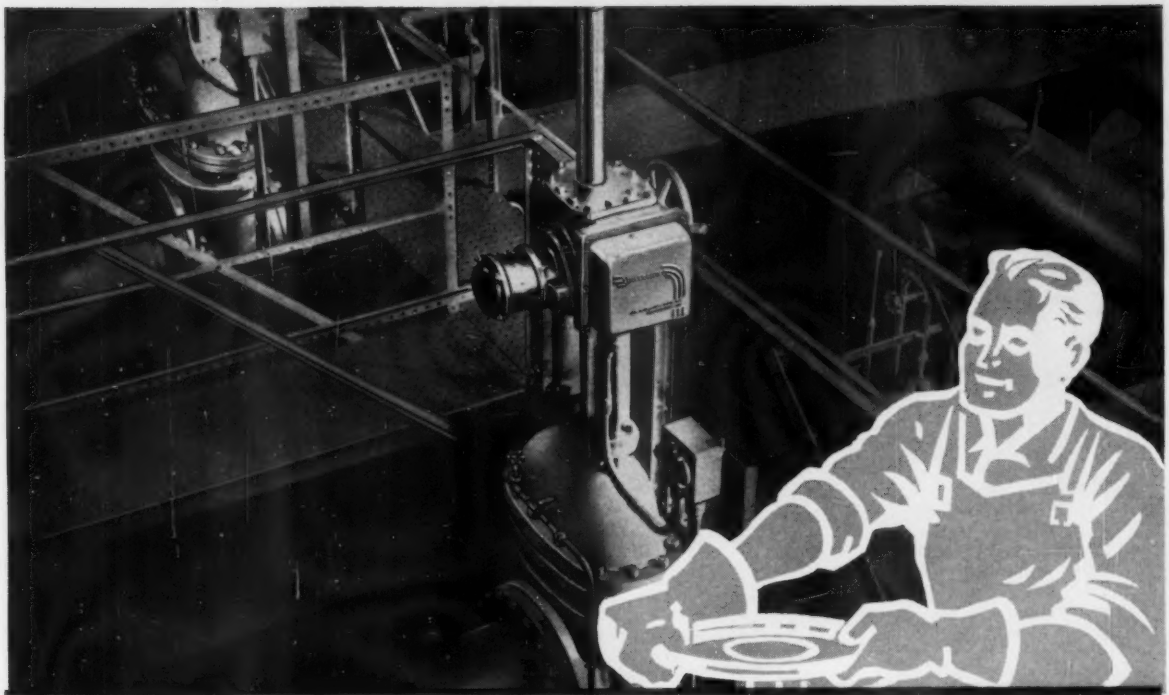

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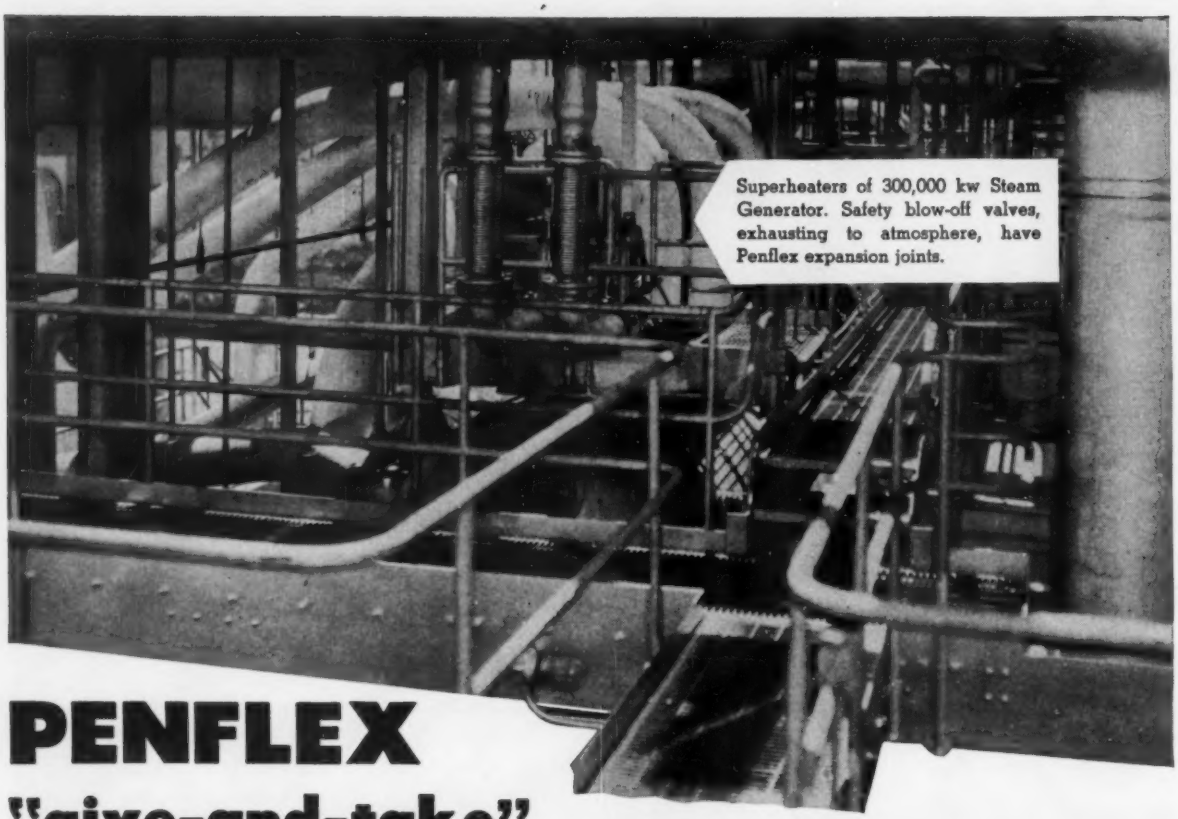

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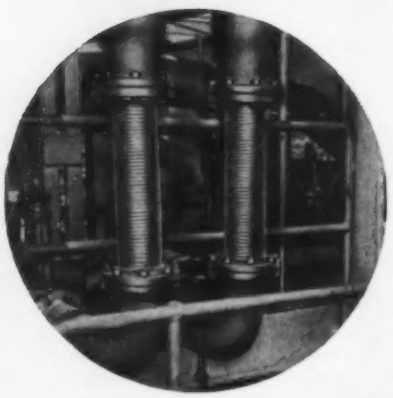
PENFLEX

"give-and-take" prevents blow-outs on blow-offs



Penflex Galvanized Steel Interlocked Tubing (8" I.D.), flanged at both ends. Installed as expansion joints on safety blow-off valves, they take up to 850 psi steam pressure at 900°F.

Power plant applications like this one can't use less than Penflex Metal Tubing offers in flexibility, strength, and tightness. When safety valves go, expansion joints must hold. Penflex joints *do*. That's because they can give with the pressure and take it, too.

Thermal expansion at 900°F. . . . pressures up to 850 psi . . . impact and pipe movement under these strains—all are safely handled by Penflex. Forty-two complete units in this big power plant are protected from blow-outs by Penflex.

There are hundreds of other applications in the steam and diesel power fields for Penflex Interlocked Tubing and Penflexweld High-pressure Tubing. Call in the Penflex engineer to help you on your own particular problems. In the meantime, write for "Flexineering," your guide in buying and using Penflex Flexible Metal Tubing. There is no charge or obligation.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7237 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles and Distributors in Principal Cities**

COMBINES FLEXIBILITY WITH DURABILITY

How many dimes can YOU save

from every lubrication dollar?

Simplify and Save the Pure Oil way

6-WAY SAVINGS!

1. Simplifies Lubrication
2. Speeds-Up Application
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Be *sure* with Pure—Sales offices located in more than 500 cities in Pure's marketing area.

Now's the time to start tightening up on production and maintenance costs. And the place to start—one place where really dramatic savings often can be made—is on *lubrication*.

Pure Oil multi-purpose lubricants—*the specially-formulated lubricants that do many different jobs equally well*—enable you to make a six-way savings that amount to real money. What's more, your lubrication program becomes *surer*, simpler, more efficient .... saves time, saves machines, saves money!

For complete information on this cost-cutting program, clip out the coupon and mail it today. It's the first step toward big lubrication savings!

It Starts Here!

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FREE BOOKLET

The Pure Oil Company, Industrial Sales Dept. E-410
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Please send me your free booklet on how to "Simplify and Save."

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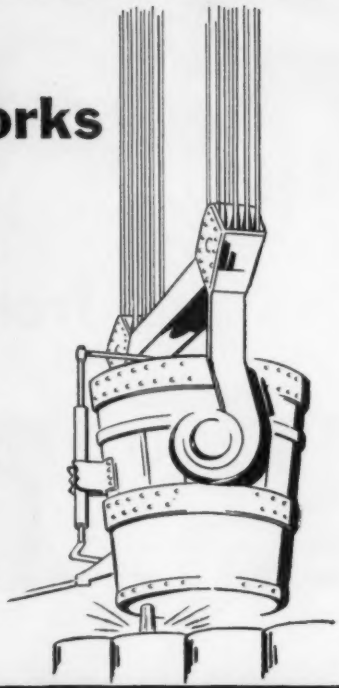
INGERSOLL-RAND BOILER FEED PUMPS

Serve Steam Plant at

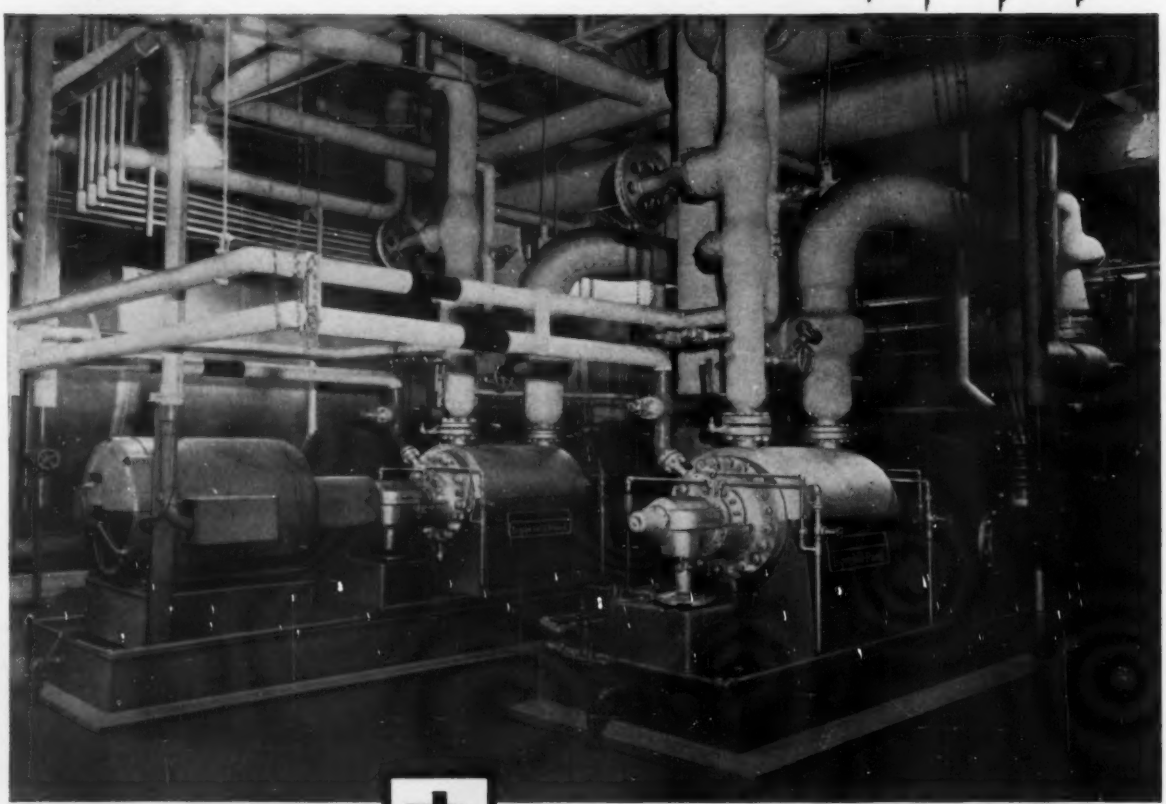
U. S. Steel's New Fairless Works



Steam, though not an *ingredient* of steel, is vital to its production, heating buildings and pickling lines, generating electric power and driving I-R pumps and blast furnace blowers. The steam plant at U. S. Steel's New Fairless Works rivals many a large central station for size, efficiency and modern equipment.

Its high pressure boilers, for example, are served by five Ingersoll-Rand Class CHTB, 7-stage boiler feed pumps, two of which are shown below. Each delivers 700 gallons of 240° boiler feed-water per minute at an intake pressure of 17 psig and a discharge pressure of 1042 psig. A steam turbine driven unit is shown in the foreground, while the pump at the rear is arranged for dual drive, either by direct-connected electric motor or steam turbine.

When it comes to boiler feed pumps, Ingersoll-Rand's experience is second to none. Why not let this know-how help you save time, effort and expense on *your* next installation. Ask your I-R representative or branch office for complete information.



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TURBO-BLOWERS • AIR & ELECTRIC TOOLS
ROCK DRILLS • VACUUM EQUIPMENT

Ingersoll-Rand

10-59

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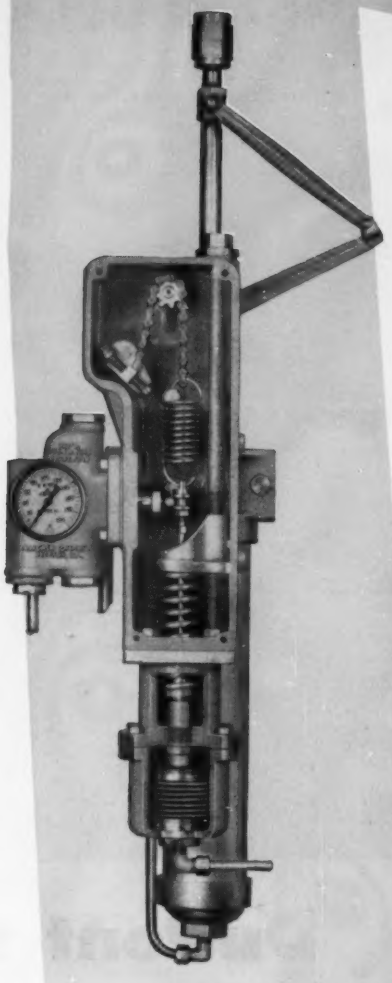
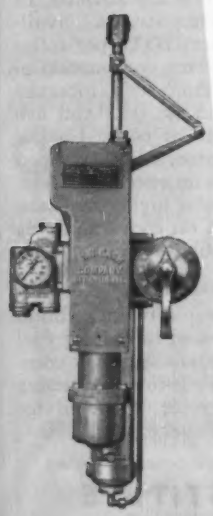
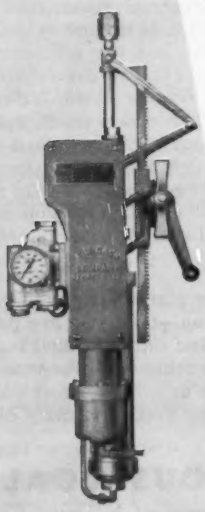
11 Broadway, New York 4, N. Y.







The CASH STANDARD 100 Series Automatic Controllers will position levers, electrical controls, valves and other processing equipment to the most exacting degree of accuracy.

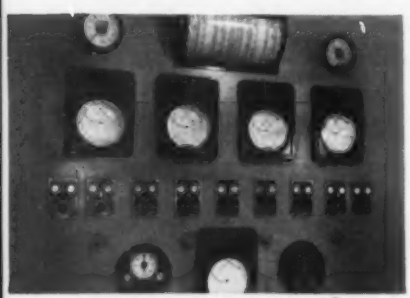
CASH STANDARD

P. O. BOX 551, DECATUR, ILLINOIS

DuPont saves $7,000 a year

with just partial modernization of coal burning equipment

The boiler plant at DuPont's Barksdale Works was operating inefficiently, due to an old forced draft system and unwieldy combustion control. DuPont engineers decided to modernize these operations, estimating that the cost would be amortized quickly through the increase in efficiency. An up-to-date draft fan and automatic combustion control system were installed. Today savings of $7,000 annually have been realized—a gross return on the investment of 140%! Not only has the new equipment paid for itself in one year, but it has produced the additional advantages of reduced ash-pit losses, lowered maintenance costs, increased steaming capacity.



Control Board at Barksdale Works. Steam generating equipment consists of four 15,000 lb./hr. 150 psi stoker-fired boilers.

Thousands Saved

More and more plants are saving thousands of dollars yearly burning coal the modern way. The reasons are obvious. In most industrial areas, coal is the cheapest fuel available. Not only do you actually get more BTUs per dollar from coal, but the efficiency of modern combustion equipment extracts even more benefit from coal's inherent energy. What's more, today's automatic coal and ash handling methods mean minimum labor costs. Coal is *clean*, too. It travels in dust-tight chutes; ashes are piped out through pneumatic tubes; there is no smoke problem. And between our vast coal reserves and highly mechanized coal production, you can count on coal remaining plentiful and its price remaining stable.

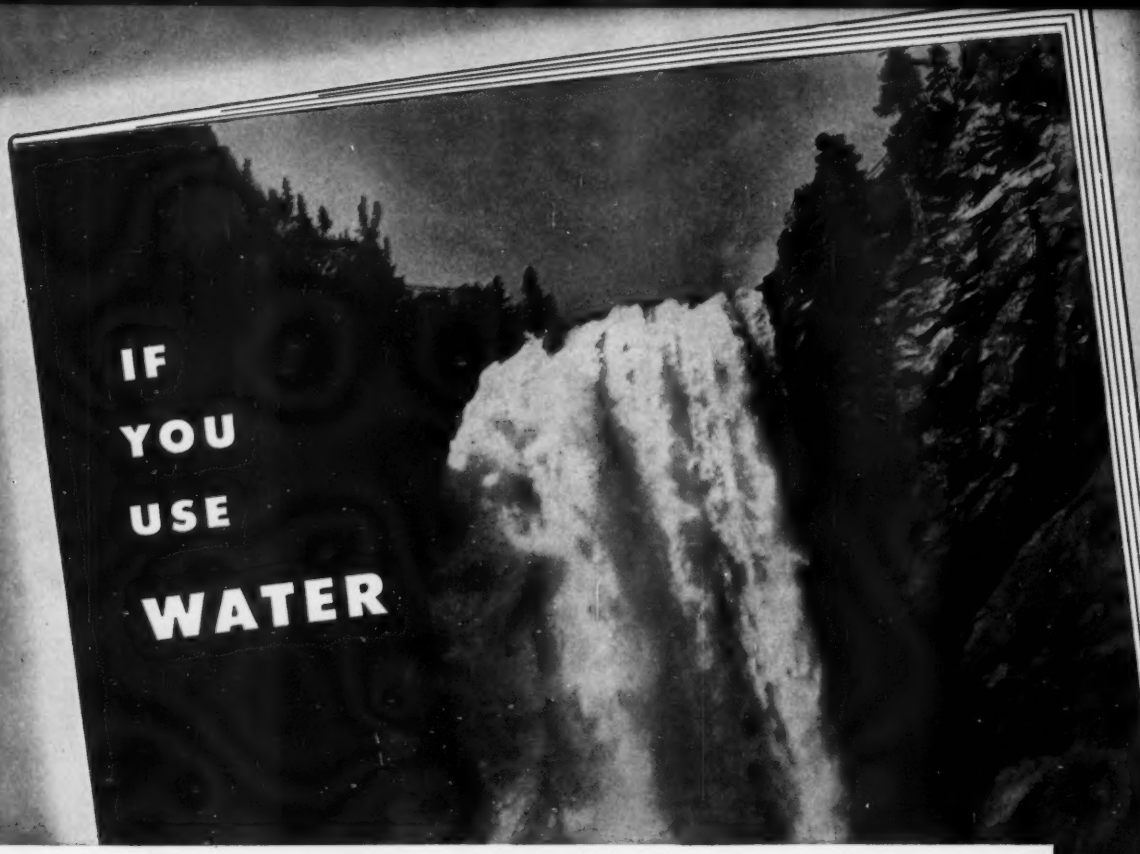
Investigate Fuel Costs

If you're planning to modernize your old plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal burned the modern way compares to other fuels for *your* plant. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

BITUMINOUS COAL INSTITUTE

A department of National Coal Association
Southern Building, Washington 5, D. C.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address above.



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Prepared by Rohm & Haas Company ion exchange specialists, "If You Use Water" shows you the way to decreased cost and increased quality of water treatment. In addition, it tells you about the use of the AMBERLITE ion exchange resins in research, medical therapy, air conditioning, television tube manufacture, food processing, printing, electroplating, and other important fields.

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Name_____

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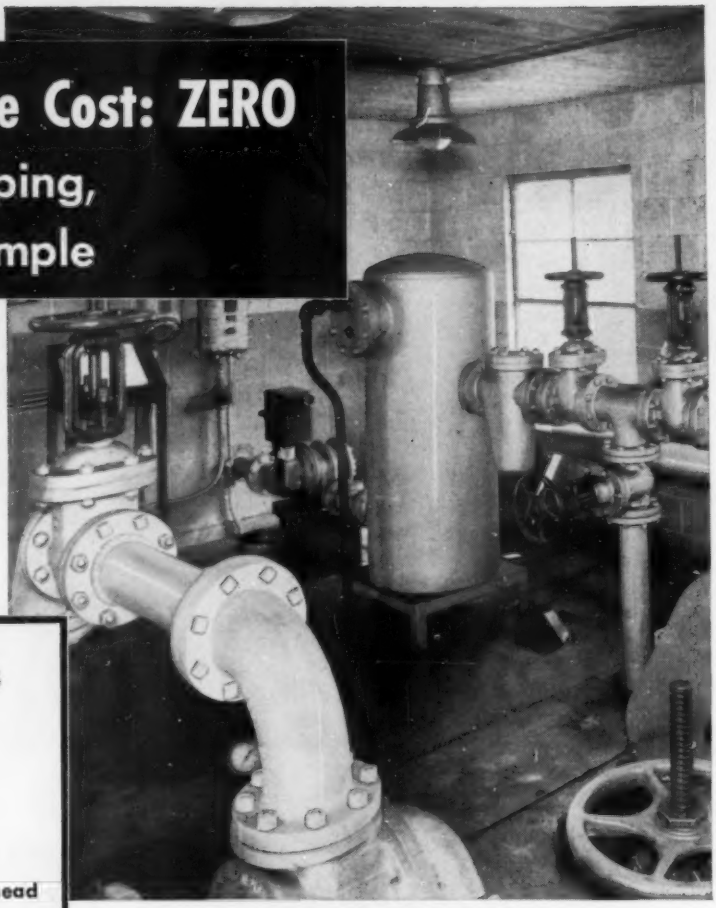
Valve Maintenance Cost: ZERO

...on fuel oil piping, for example



The Installation

At North End Yard, The Cincinnati Union Terminal Railroad, using Crane steel valves and fittings throughout diesel fuel receiving and filling system. Working pressure, 40 pounds.

Valve Service Ratings

SUITABILITY:
Doing the job as intended

FEATURES:
Exelloy seating

MAINTENANCE COST:
Zero

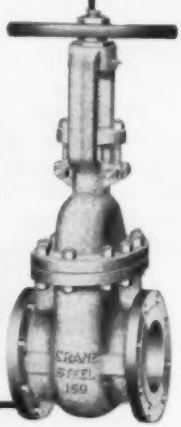
SERVICE LIFE:
Installed 1948—Shows long life ahead

OPERATING RESULTS:
Low-cost, trouble-free fueling

AVAILABILITY:
Crane catalog item—No. 47X

The Valve

150-Pound Steel Gate—with its exceptional performance assured by Crane quality design . . . by Crane pioneering skill in steel casting . . . and the high adaptability of Crane Exelloy trim for oil services. Sizes 2 to 24 in.; screwed, flanged, or welding ends. See your Crane Catalog, or ask your Crane Representative.



The Case History

Not until the terminal's engineers were convinced of its dependability and low-cost maintenance was any equipment bought for this project. Many similar systems were studied for the best means of assuring utmost economy of operation. The installation was made in 1948 . . . with welded piping where practical, using Crane materials exclusively—steel fittings, check valves, and No. 47X. 150-Pound steel gate valves.

More than 5 years later the terminal reports: Piping system operation entirely satisfactory; maintenance cost to date: zero. Further result: Crane valves have earned top consideration for proposed extension of system. The terminal knows the value of thrifty buying—quality always outweighs price-tag savings.

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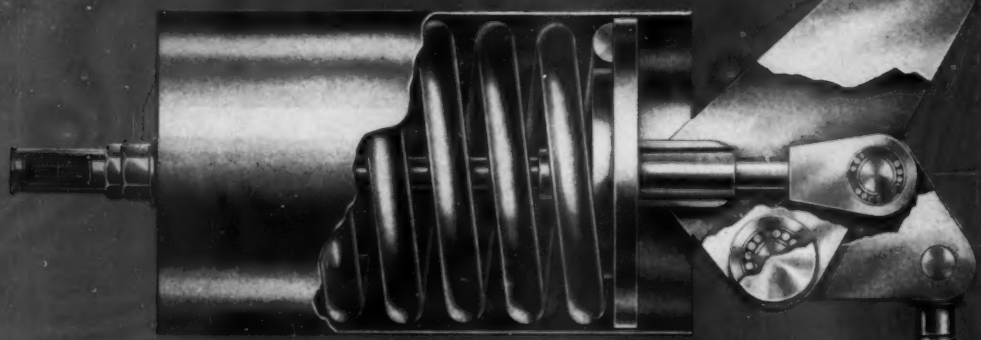
You Get Time-Tested Dependability With



NAVCO Counterpoise*

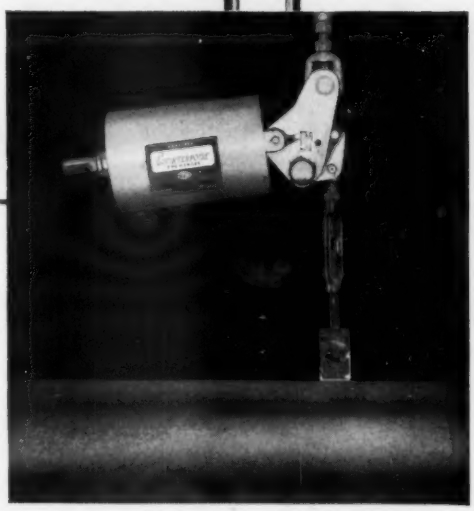
Pipe Hangers

The constant load-carrying capacity of Navco Counterpoise* Pipe Hangers has been proven during an extended period of satisfactory service as the first accurate and efficient support for high temperature piping systems. They are being used extensively in steam generating stations, refineries and chemical plants.

The Counterpoise Hanger is a spring-actuated counterbalance. An ingenious system of linkage transforms the varying force of the spring in an accurate mathematical ratio to produce a load supporting effort of constant value throughout the entire range of expansion travel.

The design permits great flexibility of installation and saves valuable space in congested areas. All parts are ruggedly made and have a high safety factor, yet excess weight and oversize physical dimensions have been avoided to hold space and structural load requirements to a minimum.

The Navco Counterpoise Hanger is available in 16 different frame sizes with load capacities ranging from 200 to 16,000 pounds and expansion travels up to 12 inches. For detailed information on how you can get dependable support with this unique hanger, write today for our 12-page illustrated bulletin #153.



Note above how the flexible top connection permits the hanger assembly to fall in line with the direction of the load pull, so that horizontal travel of the piping has no appreciable effect on the hanger operation. The unit may be positioned at any angle. This affords flexibility in installations where close clearances are a factor.

** Counterpoise is a trade name of the National Valve & Manufacturing Company*

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Pumps, Motors, Control for

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Your A-C representative frequently can make suggestions to you or your consulting engineers which result in substantial savings in time, money and trouble. And, because he represents a complete line of pumps, motors, and control, you can be sure his recommendations are impartial.

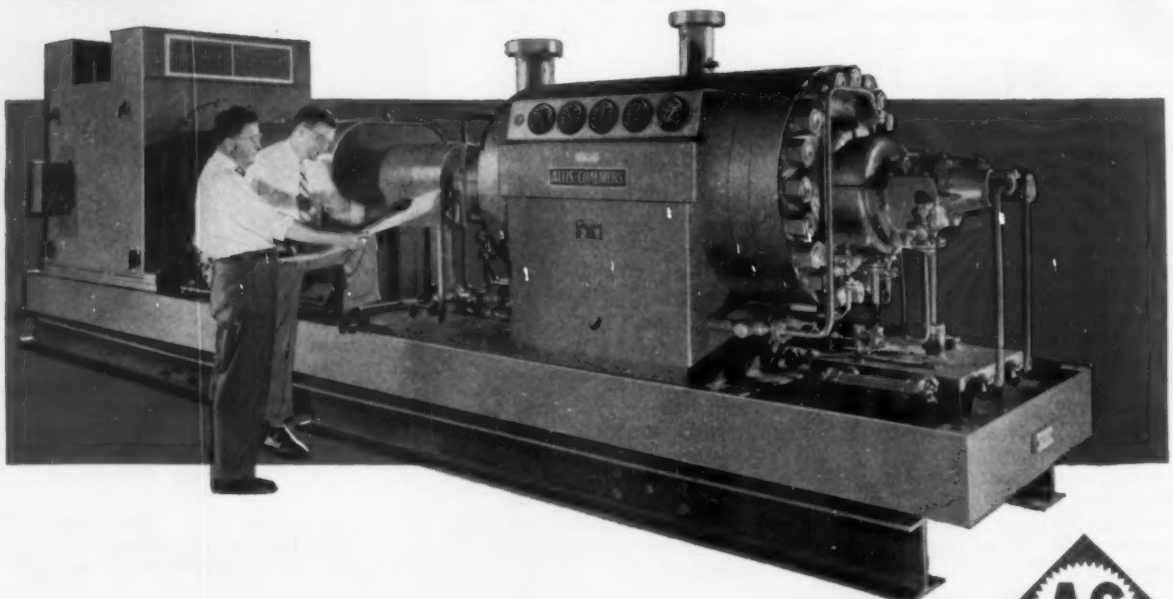
2 Coordinated Design
Specify a complete Allis-Chalmers pumping unit — pump, motor and control. Because all units come from a single source, they are designed and built to work together . . . will give you long-lived, low maintenance performance.

3 Single Responsibility for the Complete Pumping Unit . . . You get a single, dependable guarantee for all the equipment in the unit . . . a single source for parts and service . . . which minimizes paperwork, eliminates communication headaches, and facilitates prompt response to emergency calls.

Allis-Chalmers builds a complete line of boiler feed, condensate, condenser circulating, and general purpose pumps . . . motors from 1 hp up, including two-pole for boiler feed service . . . plus high and low voltage switchgear and control. Get all the facts from your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4452

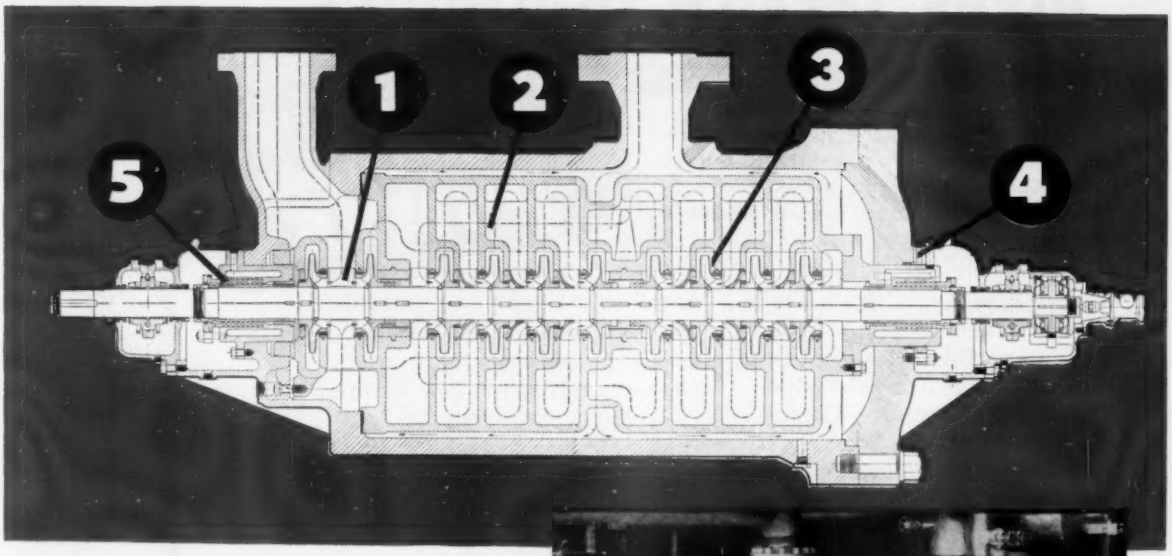
ALLIS-CHALMERS
Pumps, Motors, Control

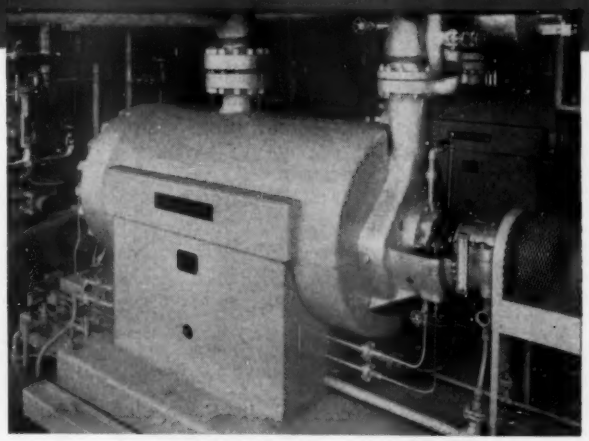


ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Get These 5 Features for Top Boiler Feed Pump Value





1 Low NPSH — First stage is two single-suction impellers face to face. NPSH requirement is very low, and interstage leakage is introduced into high pressure side of first stage to prevent flashing.

2 Double-Volute Casing — Radial thrust is neutralized regardless of variations in load. Bearings and wearing rings last longer, vibration is minimized.

3 Back-to-Back Stages — Arrangement of stages with center discharge maintains axial balance without balancing devices. Thrust from opposed stages cancels out. Any slight unbalance is taken up through a Kingsbury thrust bearing. Great simplicity reduces maintenance.

4 Easy Casing Expansion Joint Inspection — The casing expansion joint is brought to the outside where it is easy to adjust and where leakage can be detected and corrected quickly and easily.

5 Five Sealing Options — Gland seals may be standard packing, packingless, bleed-off, condensate bleed-in, or mechanical seal, depending on your exact requirements.

ALLIS-CHALMERS BARREL-TYPE BOILER FEED PUMP is the most modern high pressure boiler feed pump available today. Yet every feature has been tested and proved in power plant operation.

Check this pump point by point . . . check its performance in many power plants across the country. Get full details from your Allis-Chalmers representative or write for Bulletin 08B7899. Allis-Chalmers, Milwaukee 1, Wis.

A-4453

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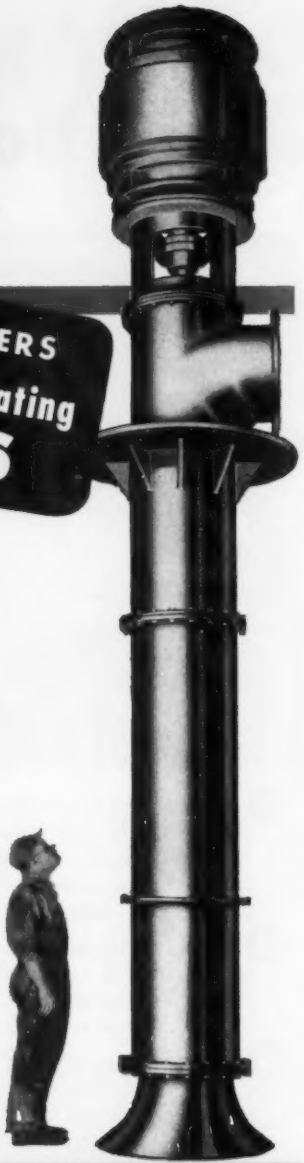
ALLIS-CHALMERS

HEAVY-DUTY CONSTRUCTION
gives service continuity

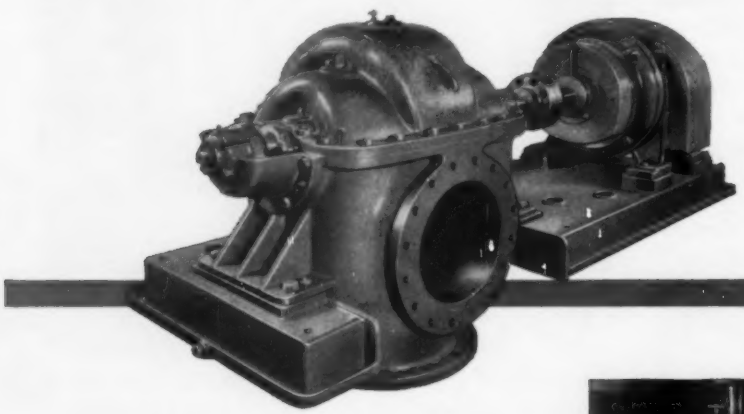
WHETHER YOU NEED a vertical or horizontal condenser circulating pump, Allis-Chalmers design gives you continuous service and lowest possible maintenance cost.

ALLIS-CHALMERS Condenser Circulating PUMPS



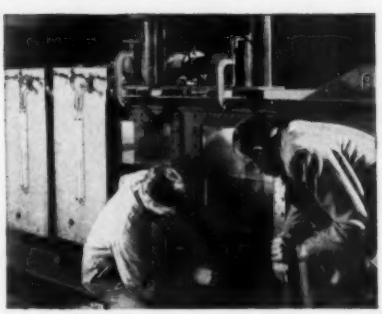
VERTICAL PUMPS — Shaft is rigid and whip-free. Underwater bearing is heavy-duty and protected against damage from sand and silt. These pumps require minimum floor space and foundation. Every possible feature to make maintenance easy has been incorporated.

HORIZONTAL PUMPS — Heavy horizontally split cast-iron casing construction is used. Suction and discharge nozzles in lower half permit easy inspection without disturbing piping. Ball or sleeve bearings available in most sizes. Generous stuffing box length contains sufficient packing to keep stuffing box maintenance low. Provision is made for sealing-water connections if required. Cast shaft sleeves, not commercial tubing, protect the shaft from wear. Sleeves extend through the stuffing box and seal the impeller hub.



Test Intake Conditions *Before* Expensive Construction Begins

Use this Allis-Chalmers test tank to duplicate your intake conditions. Know in advance exactly how your pumps will operate under every operating condition. This test tank is especially valuable where alterations in an existing intake system may produce unsatisfactory operating conditions. A-4454

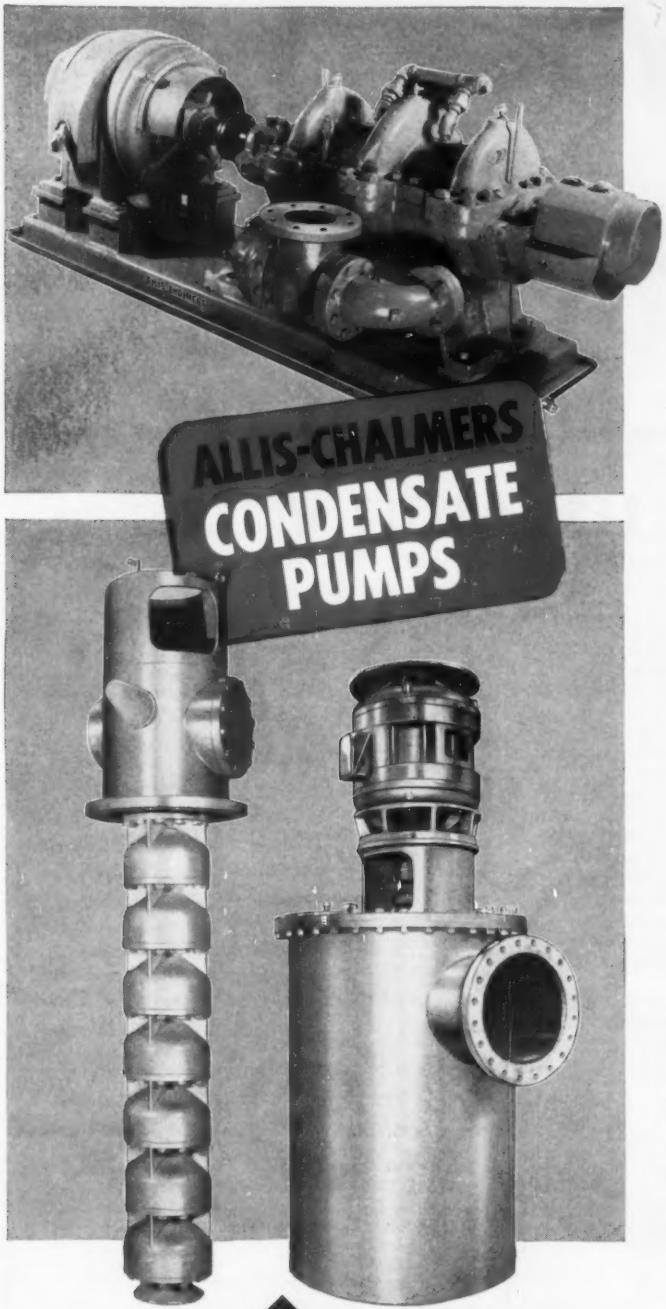


Get full information today on Allis-Chalmers Condenser Circulating Pumps or Allis-Chalmers pump test tank. Call your nearby Allis-Chalmers Office or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Get top hydraulic efficiency plus mechanical dependability



horizontal pumps

Specially designed with low NPSH requirement for high suction operation. Two or more stages depending on operating conditions. By placing the first-stage double-suction impeller between the two second-stage single-suction impellers, hydraulic balance is maintained over all conditions of load. This results in smooth operation and longer bearing and packing life. Positive pressure from the discharge of the second-stage impellers effectively seals the glands against inleakage of air. Large vents are provided in each suction chamber to insure quick removal of any vapor which may be liberated.

vertical pumps

Solves many difficult NPSH problems, since suction inlet may be above or below floor level. High head pumps are multi-stage diffuser type with individual bowls for each stage. Pump may be lowered directly in the hotwell or in its own special tank, according to the needs of the installation. Heavy duty bearings supply rigid support for the shaft and impellers regardless of the number of stages used.

WHETHER A HORIZONTAL OR VERTICAL PUMP meets your needs, Allis-Chalmers can supply you with a pump that exactly meets your requirements. For complete information and the assistance of an experienced pump specialist, call your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4455

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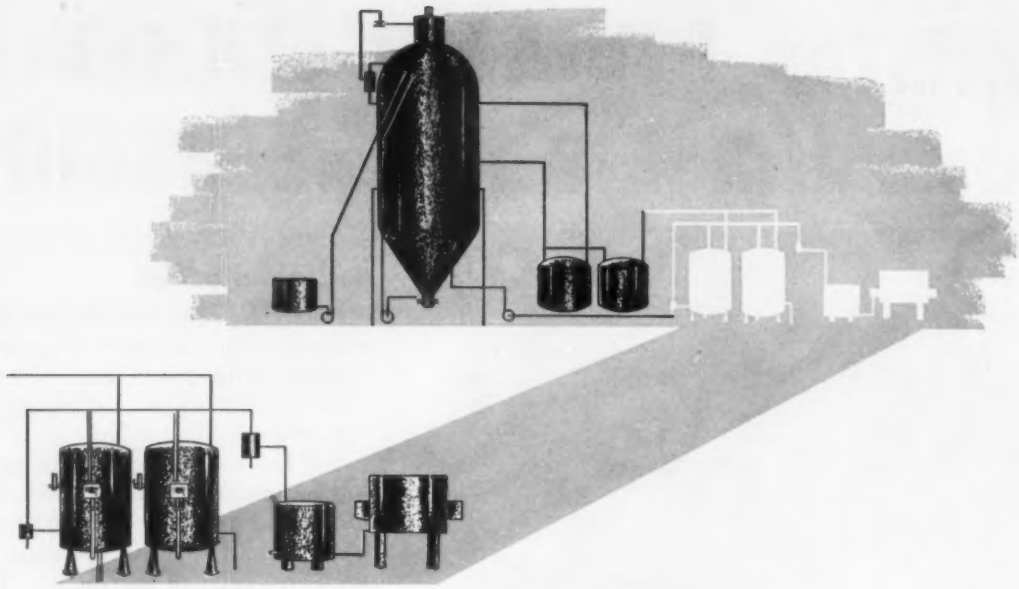
ALLIS-CHALMERS



Your present or future Hot Process + **Cochrane** ***Hot Zeolite***

= HIGHER QUALITY, LESS COSTLY WATER

For higher quality water from your present or future hot process softener . . . for economical modernization of boiler plants or for new plants . . . investigate the application of Cochrane Hot Zeolite to your system. Consult the pioneer and leader in the Hot Process field.

A Cochrane Hot Zeolite Softener, installed on the filter effluent of your system provides water of zero hardness, lowers alkalinity to approximately 25 parts per million and minimizes carbon dioxide in the steam. By proper treatment in the complete system silica can be reduced to low limits.

The use of high temperature resins produces substantial savings through the elimination of soda ash and reduction of phosphate.

Cochrane engineers and manufactures every type of precipitation and ion exchange water conditioning equipment, thus assuring you unbiased recommendations for equipment best suited to your requirements. Cochrane's *complete* service provides single responsibility for engineering, fabrication and continued satisfactory operation.

For further details on Cochrane Hot Zeolite Softeners, write for Publication No. 4801 and reprints on Hot Process-Hot Zeolite.

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Delivers solids-free, silica-free water at extremely low cost. Publication 5800.

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Delivers hot deaerated water with an oxygen content not to exceed 0.005 cc. per litre—less than 7 parts per billion! Publication 3005 and 4643.

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Slurry blanket principal efficiently removes solids, turbidity, silica, fluorides, color, taste; reduces alkalinity from water for industrial and municipal purposes. Publication No. 5001-A.

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275,000 kw, 5000 psi, 1200 F

TO THE INITIATED, the numbers above tell an impressive story. Briefly, they say that Philadelphia Electric Co executives and engineers have decided that superpressures are the next great avenue for advances in station efficiency and are backing that decision to the hilt. Not only have they aimed for new highs in pressure and temperature, they have contracted for the largest turbine-generator ever ordered.

This new plant (site to be determined) represents an initial investment of $45 million and will add more than 10% to Philadelphia Electric's present capacity.

To be built by Westinghouse, the 275,000-kw turbine-generator will be a tandem-compound 4-cylinder machine, with triple flow to a 105,000-sq-ft single-pass condenser. There will be two reheats to 1050 F.

The first, or superpressure, element is designed for 5000 psi and 1200 F, exhausting at approximately 2400 psi. Initial operation at 1150 F, with nine feed-heating stages, will yield an 8400-Btu heat rate.

Conventional design and materials characterize the remainder of the machine. The second element combines both high-pressure and first-reheat turbines in a single casing. The third comprises intermediate-pressure and single-flow low-pressure turbines. Final element is a double-flow low-pressure turbine exhausting to the condenser at 1.5 in. Hg.

Hydrogen inner-cooling of rotor and stator conductors makes it possible to build the 352,000-kva 3-phase 60-cycle 24,000-v generator for 3600-rpm operation.

Combustion Engineering is designing the once-through steam generator, of C-E Sulzer Monotube type. Maximum steam conditions are 6000 psi and 1200 F. At rated load, primary steam flow will be 1,540,000 lb per hr. First reheat stage boosts 1050-psi steam to 1050 F; second stage, 250-psi steam to 1050 F. In tangentially fired twin furnaces, tilting burners will control the reheat steam temperature.

Superheater and two reheaters will absorb more than 65% of total heat transferred in the steam generator. For this job, radiant-wall superheating surface will supplement conventional suspended superheater and reheater sections. Of approximately 150 miles of tubing, much of it 1½-in. diameter, about 80% will be alloy. Three air heaters will be regenerative type.

In addition to usual combustion controls, flow and temperature of steam and water in the boiler will be regulated by oil-hydraulic controls of the type installed in many Sulzer Monotube units in Europe.

American license rights to Sulzer designs and patents were acquired last year by Combustion from Sulzer Bros of Winterthur, Switzerland. This was the result of several years' investigation of European developments in the field of high steam pressures and once-through boilers, of which the Sulzer Monotube has been an outstanding example for many years.

Readers of POWER's exclusive series of articles on superpressures know the possibilities latent in pressures above the critical, and the problems involved in realizing them. They are thus in a position to appreciate fully the courageous nature of this forward step by Philadelphia Electric and the associated equipment manufacturers. It is this willingness to put large resources behind new engineering ideas that makes it possible for the progressive utility companies of this country to bring more power to more people at ever lower cost.

Proven On loads *UNDER* 600 Amps....

Fusetron dual-element Fuses Have an Interrupting Rating in Excess of 100,000 Amps.

An interrupting rating in excess of 100,000 amperes for FUSETRON dual-element fuses . . . this was shown by tests that were conducted under conditions that simulated the most severe field conditions. These tests were witnessed and verified by the Electrical Testing Laboratories of New York.

The test circuits were set to deliver far in excess of 100,000 amperes — yet the 250 and 600 volt FUSETRON fuses cleared the shorts without igniting readily flamable material placed around the fuses . . . and there was comparatively little noise.

These tests show that Fusetron fuses, even in the small 30 ampere range, can interrupt safely the most severe available short circuit current.

No interference with time-lag

Time-lag is of utmost importance to give proper motor and electrical protection and to eliminate needless blowing of fuses. Even though the interrupting capacity has been greatly increased, the time-current characteristic of Fusetron fuses has in no way been disturbed.

ALL THIS ADDED SAFETY

without changing a panelboard or switch . . . plus 10 point Protection of FUSETRON dual-element FUSES!

1. Protect against short-circuits. **2.** Protect against needless blows caused by harmless overloads. **3.** Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation. **4.** Provide thermal protection — for panels and switches against damage from heating due to poor contact. **5.** Protect motors against burnout from overloading. **6.** Protect motors against burnout due to single phasing. **7.** Give double burnout protection to large motors — without extra cost. **8.** Make protection of small motors simple and inexpensive. **9.** Protect against waste of space and money — permit use of proper size switches and panels. **10.** Protect coils, transformers and solenoids against burnout.

Fusetron Fuses Help eliminate needless Shutdowns for Production Engineers.

Work stoppages caused by needless blows are prevented. Even if all the motors on a circuit start at one time or other harmless overloads occur, the fuse link holds to prevent a shutdown.

Likewise, Fusetron fuses guard against needless blows caused by excessive-heating in panelboards and switches—lesser resistance results in cooler operation.

Fusetron Fuses Offer Maximum Safety for Electrical and Safety Engineers.

With an interrupting rating of 100,000 amperes, Fusetron fuses give the greatest possible protection against damage due to short-circuits. And just as important, they reduce the hazard of motor burnouts due to single phasing and overloading.

Fusetron Fuses Save Time and Work for Maintenance Engineers.

Once properly installed, Fusetron fuses require no costly inspection time or down-time for calibration and other maintenance necessary on mechanically operated devices.

Unnecessary repair work on motors is avoided because Fusetron fuses reduce to a minimum the danger of damage due to electrical faults. If trouble occurs, instead of rewinding or replacing burned out motors, simply replace Fusetron fuses.

Switches and panelboards are protected against damage from poor contact heating.

Fusetron fuses also protect against needless blows that cause irritating interruptions of regular maintenance.

Proven On loads *ABOVE* 600 and up to 5,000 Amps.

BUSS Hi-Cap Fuses Have an Interrupting Rating In Excess of 100,000 Amps. . . *and their blowing time can be coordinated with that of Fusetron fuses.*

An unlimited interrupting rating for BUSS Hi-Cap fuses on any voltage up to 600 . . . this was confirmed by tests reported by the Electrical Testing Laboratories of New York.

BUSS Hi-Cap fuses are designed to give protection against dangerous overloads as well as high fault currents — yet retain the speed of operation necessary to limit heavy short currents to safe values.

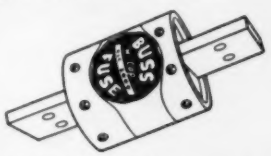
When coordinated properly with Fusetron dual-element fuses they will not open ahead of the fuse nearest to the fault — thus the trouble is isolated to the part of the circuit in which the fault occurs.

Added SAFETY on Old Installations

On installations where the increase in the capacity of the circuit has outgrown the interrupting rating of the circuit breakers, BUSS Hi-Cap fuses offer a safe and relatively inexpensive way to protect inadequate breakers against rupture in event of bad fault.

ACTION THAT SAVES YOU MONEY

Don't risk losses. Delay may cost you far more than replacing every fuse with a FUSETRON fuse. By passing the word along that all purchase and stock records should call for FUSETRON dual-element fuses on loads up to 600 amperes — and BUSS Hi-Cap fuses on loads above that, you get action that begets money saving.



On New Construction tell your architect to specify this Safer, Better Protection.

Fusetron Fuses Cuts Cost for Top Management.

Cuts maintenance cost — Fusetron fuses are maintenance free.

Cuts motor repair cost — Fusetron fuses guard the motor, against damage due to overloading, single phasing, short circuits and other electrical faults.

Cuts production costs — Shutdowns due to needless blows are eliminated.

Cuts new installation costs — Smaller sizes can be used, therefore big savings can be made on switches and panelboards.

Cuts present installation costs — Fusetron fuses hold and won't open on starting currents so the need for larger panelboards and switches is often eliminated — and in many cases new motors can be added to the circuit without installing larger panelboards or switches.

Play Safe—Install Fusetron Fuses and BUSS Hi-Cap Fuses now!

For blowing time charts or more information on FUSETRON fuses and BUSS Hi-Cap fuses use coupon or write for bulletin FIS and HCS.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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BUSSMANN Mfg. Co.
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Illustrated here are pictorial index pages from Grinnell's 92-page hanger catalog.

Grinnell has

pipe hangers and supports for every piping requirement, from simple water piping to high pressure, high temperature steam lines. No other company, anywhere, makes as complete a line of pipe hangers.

the **right** pipe hanger

If some detail of piping arrangement should make it necessary to deviate from hangers of standard design, it is important to remember that Grinnell will design and manufacture hangers to meet your special requirements. This is a service Grinnell freely offers.

to help you

Through Grinnell's efficient coast-to-coast system of strategically located warehouses and jobbers, you can purchase Grinnell Hangers "out of stock", anywhere. No other manufacturer of pipe hangers offers a distribution set-up as thorough or complete.

with every pipe hanging job!

Grinnell is ready to cooperate on all your pipe hanging assignments. For example, Grinnell will assist in the preparation of pipe suspension specifications. In addition, Grinnell, alone, of all manufacturers offers experienced field engineering service — maintains a staff of engineers who are ready to assist "on the job" with any problems in the erection of pipe hangers and supports.

GRINNELL

AMERICA'S No. 1 SUPPLIER OF PIPE HANGERS AND SUPPLIES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

a **Power** handbook

Pumps

By Tyler Hicks, *Associate Editor*

One of man's oldest aids, the pump today ranks second only to the electric motor as the most widely used industrial machine. Anything that will flow is pumped—from highly volatile ether to thick muds and sludges. Molten metals and liquids at 1000 F, or higher, pose few real problems for modern pumps.

Though the origin of pumps is lost in antiquity, we do know that crude pumping devices provided water for ancient Egypt, China, India, Greece and Rome. Today the U.S. alone draws more than 200 billion gallons each day from its water resources and pumps move almost every drop. Of this total, an impressive 80 billion gallons is said to be industry's share.

To meet these demands we find an almost confusingly large variety of available pumps. They range from tiny adjustable displacement units to giants handling well over 100,000 gallons per minute. Number of designs soars into the hundreds, some differing in elements as small as packing glands, some in the entire principle of operation.

It's neither possible nor desirable to cover every variation in a concise practical handbook such as this. So we've made a highly selective choice of widely used industrial pumps of all classes and types—the pumps you're likely to run into in your work. And we've stuck to units using mechanical means to move a liquid from one point to another, putting aside for a time such devices as ejectors, hydraulic rams, etc.

So you'll find the important facts about industrial pumping in easy-to-read form in the following 31 pages. Put them to work improving the effectiveness of your pumping operations.

OCTOBER 1954

These quick guides to the world of pumps show the major

CLASS	TYPE		IMPORTANT GENERAL FACTS
CENTRIFUGAL	Volute		The majority of centrifugal pumps built in the U.S. today are volute type. They are available as horizontal or vertical pumps, single- or multistage for wide flow ranges
	Diffuser		Diffuser-type centrifugals find many uses as multistage high-pressure units. Originally more efficient than volute-type pumps, today efficiency of both types is about equal
	Mixed-flow		Mixed-flow centrifugal pumps are ideal for low-head large-capacity applications. Usually vertical, they have a single-inlet impeller. Some horizontal units are built
	Axial-flow		Axial-flow units, often called propeller pumps, develop most of their head by lifting action of vanes, are usually vertical, and best suited for low heads, large capacities
	Turbine or regenerative		For clear liquids, turbine pumps, either horizontal or vertical, fill a need between other centrifugal and usual rotary designs. They are low- to medium-capacity, high-head
ROTARY	Gear Vane		Gear pumps consist of two or more gears (spur, single- or double-helical teeth), while vane pumps have a series of vanes, blades or buckets turned by a single rotor. This rotary class also includes lobe or shuttle-block designs
	Cam-and-piston Screw		Cam-and-piston rotaries, like most types in this class, are positive-displacement units, giving steady discharge flow. Along with screw-type pumps, and related designs, they handle a wide range of nonabrasive viscous liquids
RECIPROCATING	Direct-acting		Old standbys for years, direct-acting steam pumps now are available in many designs for handling cold or hot water, oil, and a wide range of industrial liquids of many types
	Power		Power pumps are driven from outside through a crankshaft or other device. Capacities range from very low to medium flows, at pressures up to 15,000 psi, or higher
	Crank-flywheel		Crank-and-flywheel pumps are one form of reciprocating power pump, so designated to distinguish them from power pumps using, for example, an eccentric as drive mechanism

classes and types in use today

	Centrifugal		Rotary	Reciprocating		
	Volute and diffuser	Axial flow	Screw and gear	Direct-acting steam	Double-acting power	Triplex
Discharge flow	Steady	Steady	Steady	Pulsating	Pulsating	Pulsating
Usual max. suction lift, ft	15	15	22	22	22	22
Liquids handled	Clean, clear; dirty, abrasive; liquids with high solids content		Viscous, nonabrasive	Clean and clear		
Discharge pressure range	Low to high		Medium	Low to highest produced		
Usual capacity range	Small to largest available		Small to medium	Relatively small		
How increased head affects:						
Capacity	Decrease		None	Decrease	None	None
Power input	Depends on specific speed		Increase	Increase	Increase	Increase
How decreased head affects:				Small		
Capacity	Increase		None	increase	None	None
Power input	Depends on specific speed		Decrease	Decrease	Decrease	Decrease

DEFINITIONS

PUMPING is the addition of energy to a liquid to move it from one point to another

CENTRIFUGAL PUMPS employ centrifugal force to develop a pressure rise for moving a liquid

ROTARY PUMPS use gears, vanes, pistons, screws, cams, segments, etc, in a fixed casing to produce steady positive displacement of a liquid

RECIPROCATING PUMPS use pistons, plungers, diaphragms or other devices to positively displace a given volume of liquid during each stroke of the unit

IMPELLER is the rotating element in a centrifugal pump through which liquid passes and by means of which energy is imparted to the liquid

CASING of a centrifugal pump is the housing surrounding the impeller. It contains the bearings for supporting the shaft on which impeller mounts

LIQUID PISTON OR PLUNGER of a reciprocating pump is the moving member that contacts the liquid and imparts energy to it

SINGLE-STAGE centrifugal pump is one in which total head is developed by one impeller

MULTISTAGE centrifugal pump is one having two or more impellers acting in series in one casing

Pumps . . . major classes and types

The world of pumps can be extremely confusing to newcomers—and even to some oldtimers. Diagram, *left*, is designed to clear up much of the mystery and confusion surrounding pump *classes* and *types*. You might call it your road map to the world of pumps. Based on often-used standard classifications, it incorporates a number of useful facts that are a big help in pump selection and application.

Three classes of pumps find use today—*centrifugal, rotary* and *reciprocating*. Note that these terms apply only to the mechanics of moving the fluid, not to the service for which the pump is designed. This is important, because many pumps are built and sold for a specific service, and in the complex problem of finding which has the best design details we may overlook the basic problems of class and type.

Each classification is further subdivided into a number of different types, diagram *left*. For example, under the rotary classification we have cam, screw, gear and vane pumps. Each is a particular type of rotary pump.

To go one step further, let's take a brief look at a fuel-oil pump in wide use today. It is a rotary three-screw type available with rotors of a number of different materials and four means of balancing axial thrust.

The last two items are important *details* in pump application; first two are keys to classification of the unit. The Hydraulic Institute recommends that the standard classification be considered as applying to type only, leaving the builder to use the details he has developed or standardized for that type of pump. So in selecting a pump we often find we must compare, detail for detail, a number of makes. Broad breakdown in diagram comes in handy then.

Our next consideration is a wide statement of the general characteristics of a given class of pumps. Table, *above left*, does just this for us.

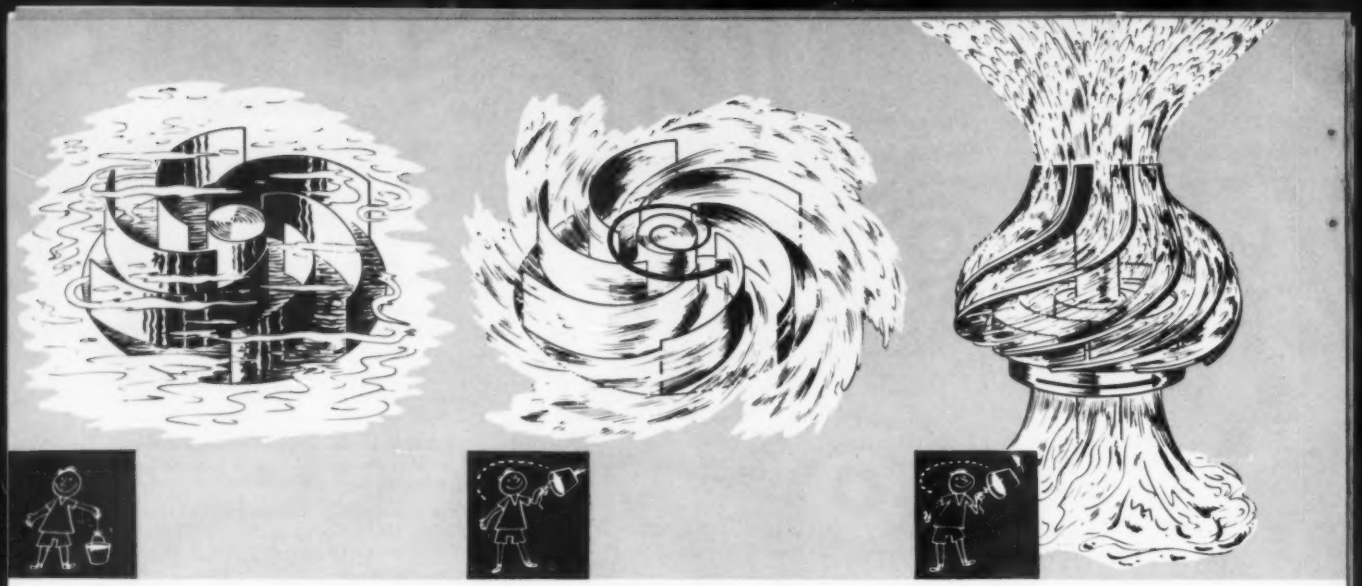
For example, if we want to handle relatively small capacities of clean, clear liquids at high head, we can refer to the table. In any problem of this type we must remember that suction lift should not exceed recommended limit. Capacity in gallons per minute (gpm) determines pump size and influences classification. Nature of fluid is also involved, as is pump construction. Head is a big factor.

Table shows a reciprocating pump is suitable for the general conditions we have in mind—small capacity, high head, clean, clear liquids. Then, depending on job needs, we may choose a piston or plunger type, direct-acting, crank-and-flywheel, or power type. It may be simplex, duplex, triplex, or have a larger number of cylinders.

Once we've settled these items we're ready to study valve details, materials, drives, etc. In general, you'll find that pump details are greatly influenced by job requirements. Thus the particular arrangement of a centrifugal pump may depend as much on piping, space and working conditions as on any other existing factors. Drive chosen for the pump may be fixed by the pump speed, plant heat balance, power supply available or cost of a particular fuel in the area. But again, these are details, to be decided after we find a pump suitable for the hydraulic conditions we must meet. And the key to meeting the hydraulic conditions is the right class and type of pump.

Where two or more different units meet hydraulic needs, we must go one step further and decide which pump is best for the installation. We may want or need low first cost, long life or maximum operating economy. Normally we do not find all in one package. So we must decide which is most important and go ahead from there.

Getting the right pump is much like coming to a fork in the road. Our map tells us which way to turn. Once on the right road all we need do is watch our route markers. The next 29 pages do just that for you in the world of pumps.



CENTRIFUGAL

As a boy you probably whirled around your head a bucket on the end of a rope, just like the little guy in the three sketches above. As you recall, the water stayed in the bucket just as long as you kept it turning at a fair speed. The force that kept the water in the bucket is at work in centrifugal pumps.

Imagine an impeller at rest in water, *above left*. This is like the lad's bucket before he starts whirling it. Now rotate the impeller, *middle sketch*. Water will fly out from between the blades just as it would squirt out of the whirling bucket if it had a hole in the bottom.

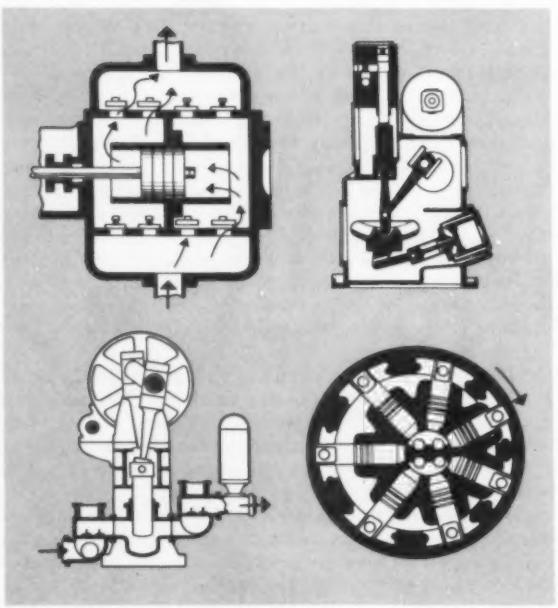
The force causing the water to leave the impeller (or the bucket) is *centrifugal force* and that's where pumps of this class get their name. They depend on centrifugal action even though details differ, as we'll see later.

Going back to the middle sketch, as the impeller throws out liquid, more rushes into the center where the lowest pressure exists, and where a suction pipe is normally fitted. This liquid too is thrown out, is followed by more, and we have the steady discharge characteristic of centrifugals.

Once the liquid is being thrown from the impeller we must guide it to its destination. Otherwise we've accomplished little more than make a big splash.

By putting the impeller in a casing we can change flow from haphazardly outward to controlled movement in the direction we want. With vanes like those of the deepwell pump in the righthand sketch we can even turn the flow upward. A casing, with or without vanes, acts something like a hose attached to the bottom of the boy's bucket.

The result is a workable pump for imparting energy to a liquid at one point to cause it to move to another.



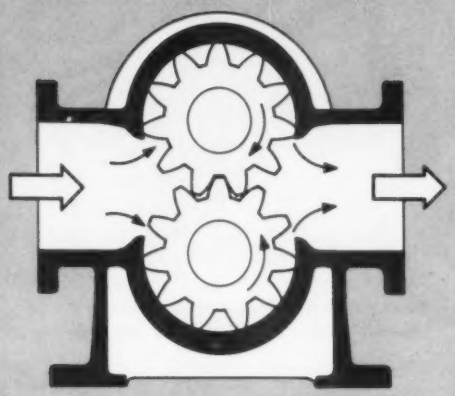
RECIPROCATING

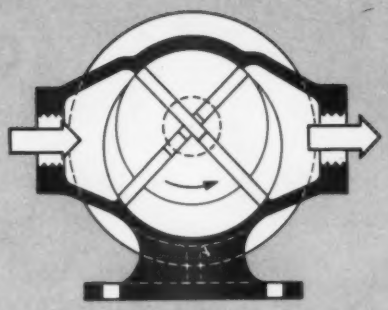
Long of major importance in the pumping field, reciprocating units today are finding many new uses, particularly in the fields of metering and proportioning, and where extremely high pressures are needed.

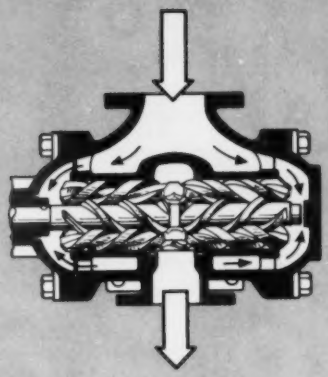
Direct-acting steam pumps, *top left*, have two sets of valves in the liquid end. When the piston moves to the left as shown, liquid is drawn in through the righthand set of suction valves and liquid previously drawn into the cylinder is discharged through the upper left set of discharge valves. This is a double-acting pump, liquid being discharged on every stroke. The actual arrangement of the valves differs in various designs.

Power pumps, *top right and lower left*, have a number of different arrangements for suction and discharge valves. In these two single-acting units, liquid is drawn into the cylinder during one stroke of the plunger. On the next stroke, the plunger forces liquid through the discharge valves into the pump outlet.

Radial-piston pumps, *lower right*, one of many relatively recent designs, have their pistons attached to an outer ring whose center of rotation can be changed. Moving the ring to an eccentric position produces suction and discharge through valves in the center of the pump. Reversing the direction of ring rotation reverses liquid flow. A large number of other designs are discussed later, pp 90-95.







ROTARY Like reciprocating pumps but unlike centrifugals, most rotary pumps are positive-displacement units – that is a given quantity of liquid is discharged for each revolution of the shaft. Like the centrifugal pump, flow is usually steady, without large pressure pulsations.

Rotary gear pumps, *above left*, have two or more gears in a casing and during rotation the liquid fills the spaces between the gear teeth on the suction side. From there it is carried around and squeezed out as the teeth mesh on the other side of the pump.

Sliding-vane rotary pumps, *above center*, are built in a number of different designs. In the type shown, the vanes move in and out of the rotor, which is set off-center in the casing. When the rotor turns counterclockwise, liquid flows into the cavity formed by rotor bottom and casing wall.

As the rotor turns, it brings the next vane into position to trap the liquid in the cavity. Further rotation forces the liquid around and out the discharge opening of the pump. The vanes are held against the inner wall of the casing by centrifugal force produced by rapid rotation of the rotor.

Screw pumps, *above right*, draw the liquid into one or both ends of the rotor or rotors, where it is trapped in the pockets formed by the threads. It is moved along to the discharge point much like a nut on a thread. Screw-type rotary pumps may have one, two or three screws. When only a single screw is used, liquid enters at one end, is discharged at the other. The screw runs in a double-threaded helix. Clearance is an important factor in many rotary-pump designs that are used today.

Later, pp 88, we'll discuss the large number of other rotary-pump designs used for a variety of industrial services.

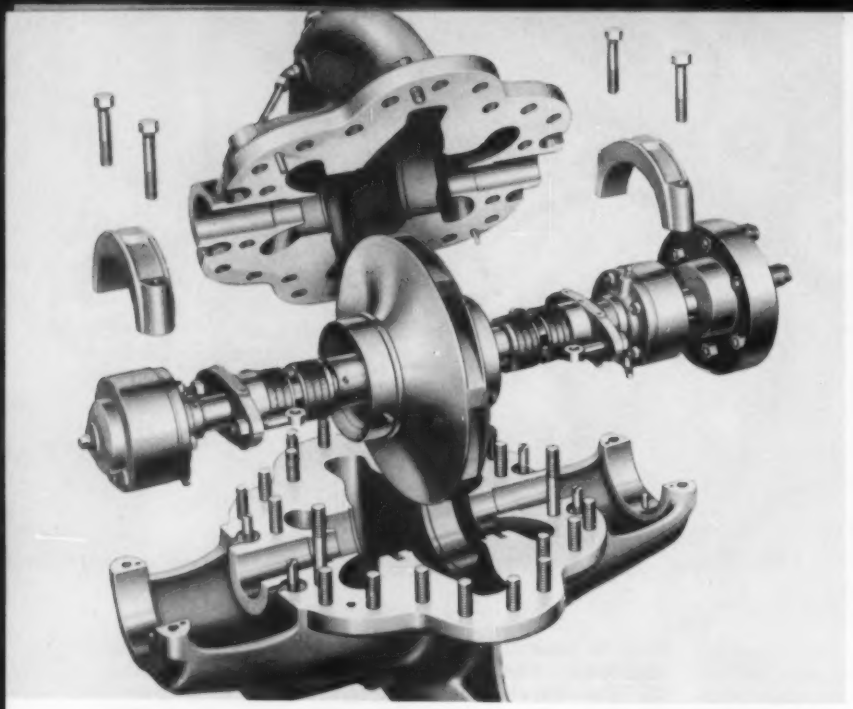
How pumps work

OTHER PUMPING PRINCIPLES

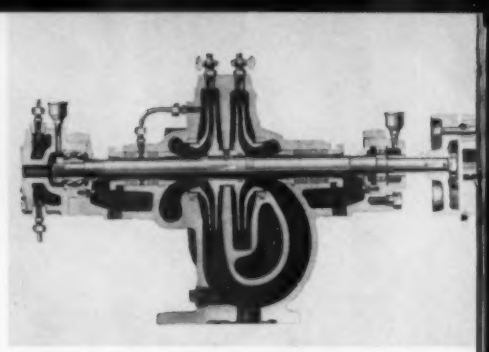
Some of the most interesting recent design developments are in pumps for process and nuclear-energy applications. To handle liquid metals, for example, we now have electromagnetic pumps, in which electrical energy is applied directly.

Electromagnetic pumps include the Faraday type for ac or dc power, the ac linear-induction design (a modification of this is called the Einstein-Szilard pump) and the electromagnetic centrifugal. These, and other similar designs, represent new approaches to the problem of moving a liquid from one point to another.

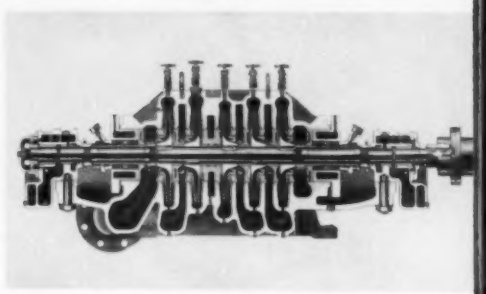
Among older ideas for moving liquids there are, of course, the familiar air lift, hydraulic rams, and the Humphrey pump. Here, however, we stick to common mechanical methods.



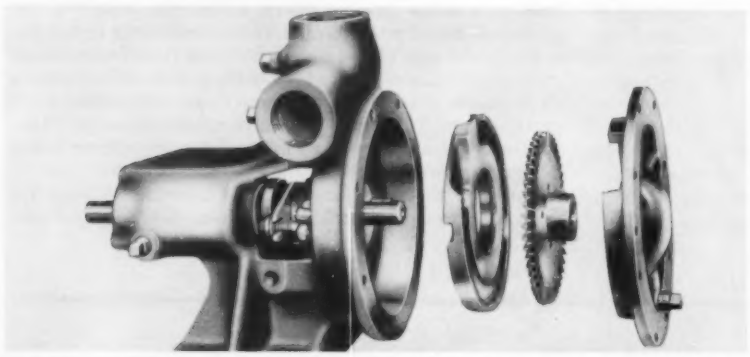
SINGLE-STAGE general-purpose pump has horizontally split casing, water-sealed stuffing boxes, cast-iron double-suction casing. The impeller is made of bronze



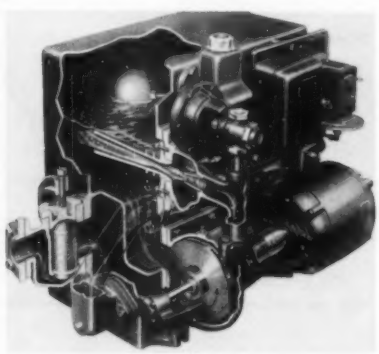
TWO-STAGE horizontally split pump has opposed impellers, ball-type bearings



MULTISTAGE single-suction opposed-impeller pump for continuous heavy duty



HORIZONTAL TURBINE PUMP, single stage, is self-venting to prevent vapor binding. Units like this are built with standard stuffing boxes, or with a mechanical seal



ENCLOSED-TYPE non-overload impeller on stainless-steel shaft for vacuum service

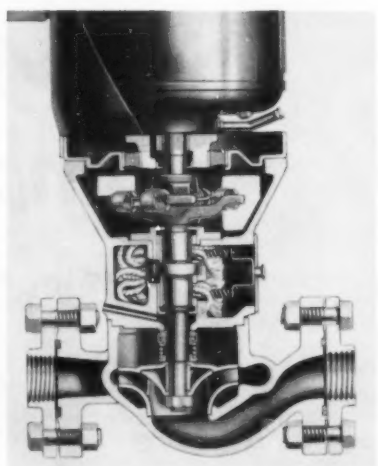
Centrifugal pumps

Earlier we saw how modern pumps are classified and typed. Now we're ready to take a closer look at centrifugal pumps – the most widely used units.

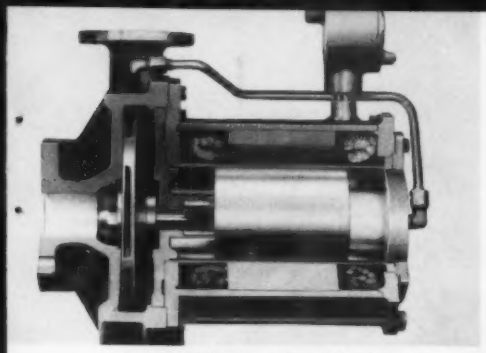
Illustrations on these two pages are a small sampling of today's designs. Study shows that though all come under one broad classification, intended application is a major factor in impeller and casing design, materials used, and other mechanical and hydraulic features. For these reasons we find pump builders stressing ultimate use somewhat more than classification and type.

Thus centrifugal pumps are termed boiler-feed, general-purpose, sump, deep-well, refinery (hot oil), condensate, vacuum (heating), process, sewage, trash, circulating, self-priming, sanitary, bait, booster, paper stock, chemical, fire, jet, sand, slurry, ash, glass, stoneware, submersible, tail-water, etc. In general, each has specific features of design and materials recommended by the builder for the particular service. This makes selection and application easier.

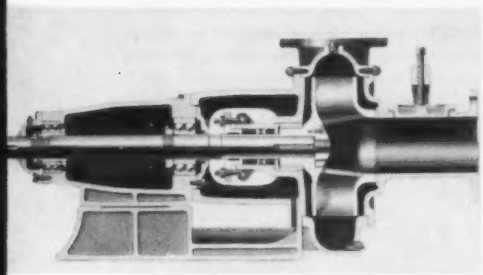
Another subdivision grows out of broad structural features. Thus we find horizontal and vertical units, close-coupled designs, single- and double-suction impellers, horizontally split casings and barrel casings, etc. Correct evaluation of all these variations is one of the big jobs in selecting a pump.



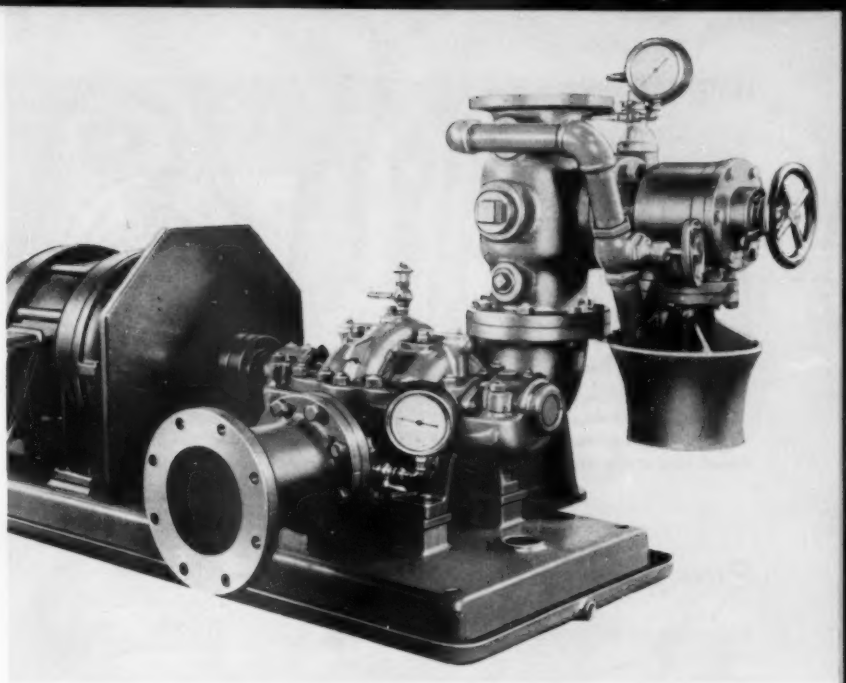
SINGLE-STAGE pump with sleeve bearings and mechanical seal for hot-water uses



SEAL-LESS leakproof combined motor-pump has no stuffing boxes, uses no lubricant

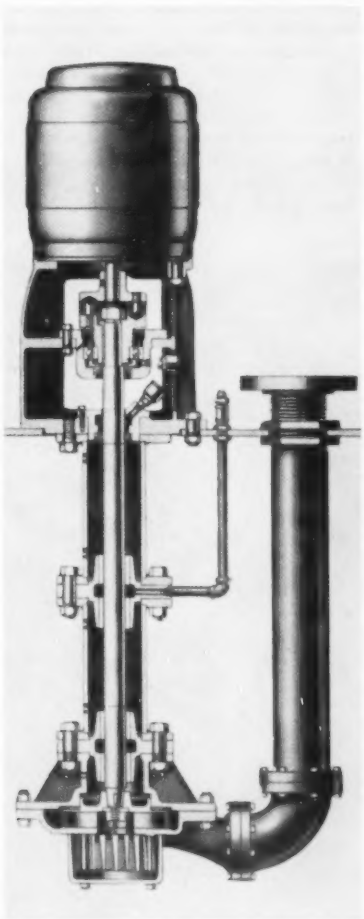


NON-CLOGGING PUMP: 2-bladed impeller, ball bearings, removable suction cover



SUCTION SIDE of a single-stage fire pump, complete with motor and fittings. Pumps and fittings for this service are laboratory tested before underwriters' approval

MIXED-FLOW vertical pump may be either water or oil lubricated, depending on job

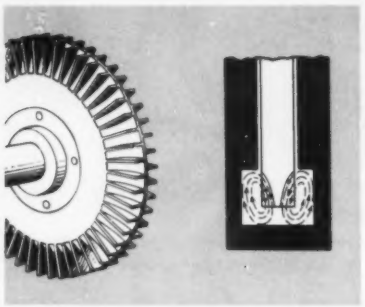


VERTICAL single-stage unit has semi-open impeller, ball and sleeve shaft bearings

WATER-LUBRICATED vertical pump: semi-open impellers, open line-shaft bearings

VOLUTE converts velocity energy of the liquid into static pressure (read in psi)

DIFFUSER changes flow direction, aids in converting velocity energy to pressure



TURBINE pump adds energy to the liquid in a number of impulses during rotation

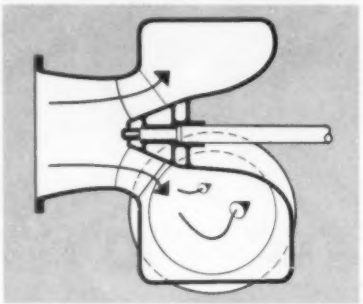
Pump action

In volute-type pumps the impeller discharges into a progressively expanding spiral casing, proportioned to gradually reduce liquid velocity. Thus velocity energy is changed to pressure head in the volute.

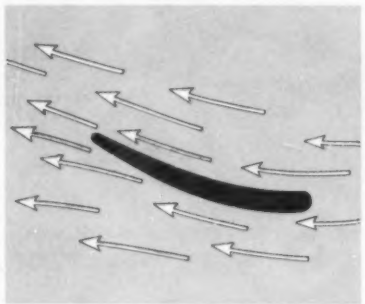
Stationary guide vanes surround the runner in a diffuser-type pump. These gradually expanding passages change the direction of liquid flow and convert velocity energy to pressure head.

Liquid in a turbine pump is picked up by the impeller's vanes and whirled at a high velocity for nearly one revolution in an annular channel in which the impeller turns. Energy is added to the liquid in a number of impulses, so it enters the discharge at high velocity.

Mixed-flow pumps develop their head partly by centrifugal force and partly by the lift of the vanes on the liquid. Propeller pumps develop most of their head by the propelling or lifting action of the vanes on the liquid.



MIXED-FLOW units use both centrifugal force and lift of vanes on the liquid



PROPELLER pump develops most of its head by propelling action of vanes on liquid

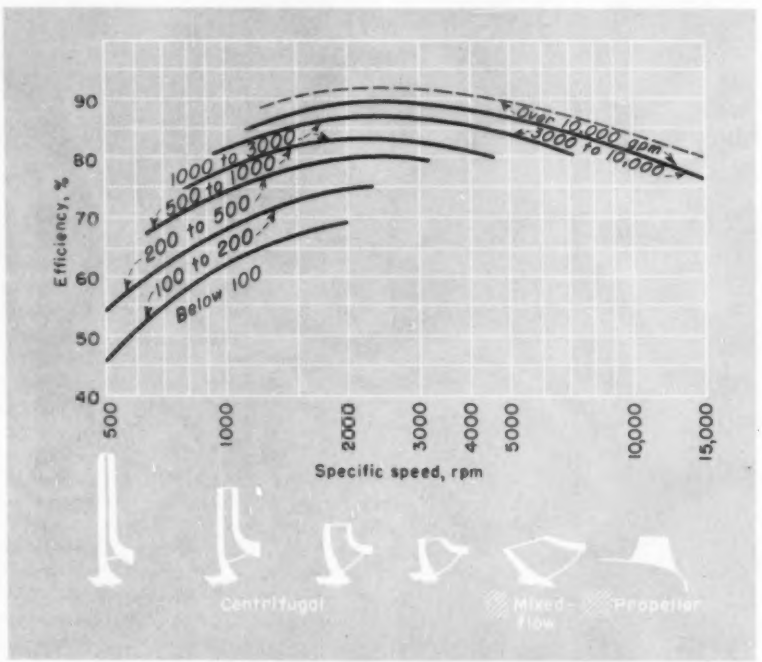
Specific speed

Specific speed is an index of pump type, using the capacity and head obtained at the point of maximum efficiency. It determines the general profile or shape of the impeller. In numbers, specific speed is the rpm at which an impeller would run if reduced in size to deliver 1 gpm against a total head of 1 ft.

Impellers for high heads usually have low specific speed; impellers for low heads have high specific speed.

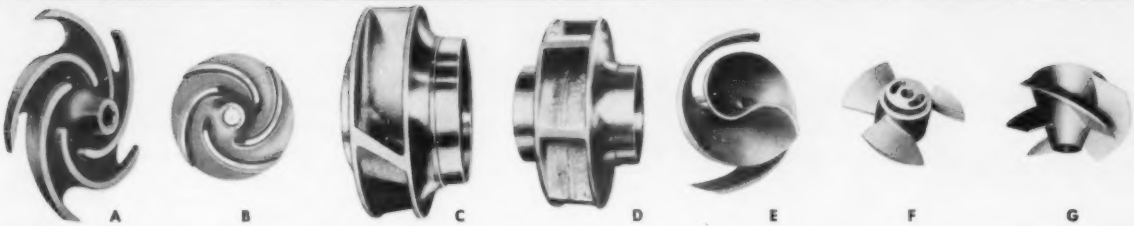
As diagram, *right*, shows, each impeller design has a specific-speed range for which it is best adapted. These ranges are approximate, without clear-cut divisions between them. Chart gives general relations between impeller shape, efficiency and capacity.

Suction limitations of different pumps bear a relation to the specific speed. The Hydraulic Institute publishes charts giving recommended specific speed limits for various conditions.



SPECIFIC SPEED is approximately related to impeller shape and efficiency, as shown by these curves. There is no sharp dividing line between various impeller designs

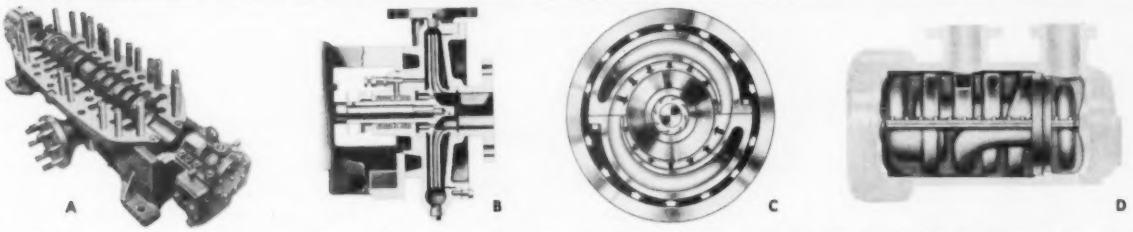
Impellers



Besides being classified according to specific speed, an impeller is also typed as to how the liquid enters, its vane details, and use for which it is intended.

Open impellers, *A*, have vanes attached to a central hub with relatively small shrouds. *Semi-open, B,* have a shroud, or wall, on only one side. *Closed* impellers, *C* and *D*, have shrouds on both sides to enclose liquid passages. *Single* or *end-suction* units, *C*, have liquid inlet on one side; in *double-suction* type, *D*, liquid enters both sides. *E*, *F* and *G are paper-stock, propeller and mixed-flow* designs.

Casings

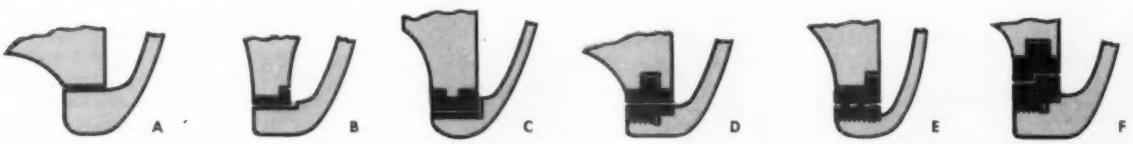


Centrifugal-pump casings may be split *horizontally, A, vertically, B,* or *diagonally* (at an angle other than 90 deg).

Horizontally split casings are also termed *axially* split. Both suction and discharge nozzles are normally in lower half of casing; upper half lifts for easy inspection. Vertically split casings are also called *radially* split. They're used in close-coupled or frame-mounted end-suction designs.

Barrel casings, C and *D,* are used on high-pressure diffuser and volute pumps. Inner casing fits in outer barrel. Discharge pressure acting on inner case provides seal.

Wearing rings

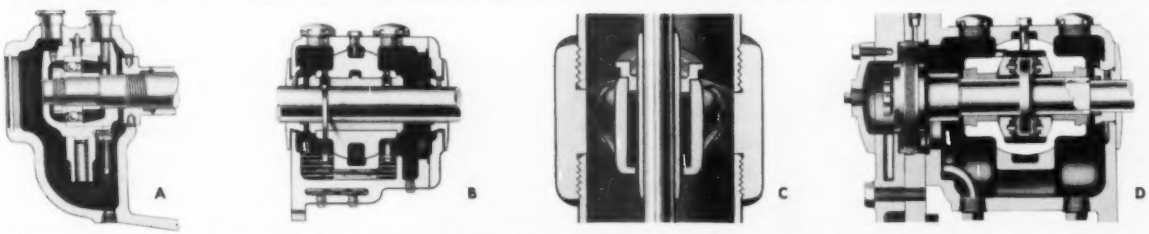


To prevent costly wear of casing and impeller at the running joint, wearing rings, also called casing rings, are installed. Where these rings are removable, as they usually are, they can be replaced at a fraction of the cost of a new impeller or pump casing that might otherwise be needed.

Seal *A* is a plain flat joint. Similar joint, *B*, has a flat ring mounted on the pump casing. At *C* the ring fits into a casing groove; impeller has a similar ring.

In designs *D, E,* and *F,* rings are fitted to both casing and impeller. Form varies with pressure, service, etc.

Bearings



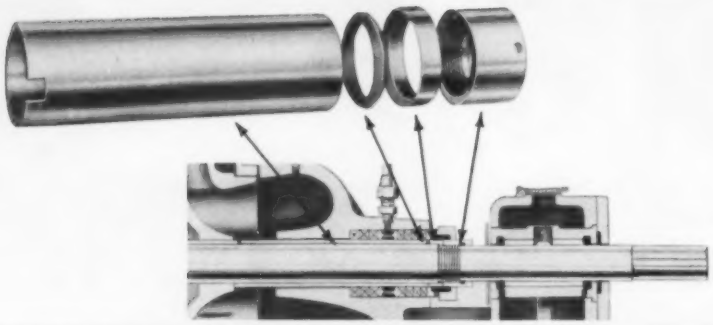
Practically every type of bearing has been used in centrifugal pumps. Today, *ball, sleeve* and *Kingsbury* bearings find most common use. Many pumps are available with more than one type of bearing to meet different needs.

Ball bearings, *A*, may be of single- or double-row type. Spherical roller bearings are widely used for large shafts.

Sleeve bearings, *B* and *C*, may be either horizontal or vertical. In the latter, water is often the lubricant.

Kingsbury thrust bearings, *D*, find use in larger pumps. Design resembles that used in other rotating machinery.

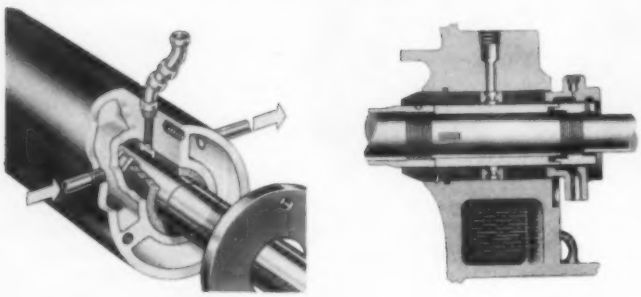
Shaft and interstage sleeves



Sleeves protect shaft against corrosion, erosion and wear affecting its strength. Many forms are used on large pumps but on small ones sleeve is often left off to cut hydraulic and stuffingbox losses. Shaft is then made of a metal that is sufficiently corrosion- and wear-resistant for satisfactory life.

Interstage sleeves guard multistage pump shafts. In some, long hub on impeller replaces interstage sleeve.

Lantern rings

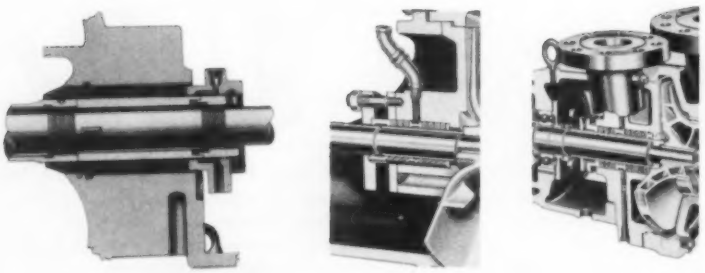


These are used to prevent air leakage into pump when running with a suction lift and to distribute sealing liquid uniformly around annular space between box core, shaft-sleeve surface.

Also called seal cages and waterseal rings, they receive liquid under pressure from pump or independent source.

Grease sometimes serves as sealing medium when clear liquid isn't available or can't be used (sewage pumps).

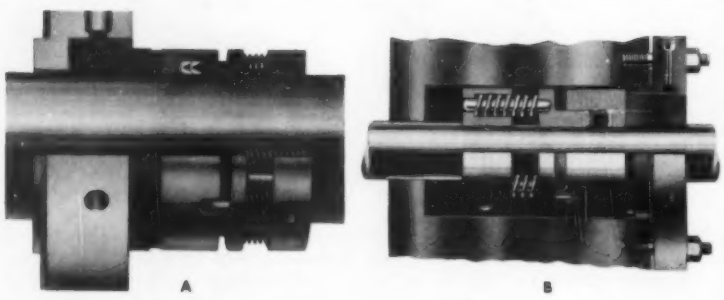
Stuffing boxes



Stuffing box stops air leaking into casing when pressure is below atmospheric; holds leakage out of casing to a minimum when pressure is above.

Sketches show solid-packed box, which has no lantern rings; two injection designs, which do. On pumps handling hot liquids, or having high stuffing-box pressures, box is often water-jacket cooled. In some, coolant and pumped liquid mix.

Mechanical seals



A B

Mechanical seals in wide variety serve where leakage is objectionable. They also find use where stuffing-boxes can't give adequate leak protection.

Sealing surfaces are perpendicular to pump shaft and usually comprise two polished lubricated parts running on each other. Though not guaranteed leakproof, leakage is usually nil.

Outside type, *A*, is used where gritty liquids or leakage retained in stuffing box would be undesirable. *Inside*, *B*, finds much use for volatile liquids.

HYDRAULIC INSTITUTE MATERIALS SELECTIONS AND DESIGNATIONS

Institute selection no.	Corresponding national society standards designation ASTM	ACI	AISI	Remarks
1	A 48, Grades 20, 25, 30, 35, 40, & 50	.....	.....	Gray iron — six grades
2	B 143, 1 B & 2A; B 144, 3A; B 145, 4A	.....	.....	Tin bronze — six grades (includes two grades covered in detail in *Standards of Hydraulic Institute*)
3	A 216, WCB	.....	1030	Carbon steel
4	A 217, C5	.....	501	5% Chromium steel
5	A 296, CA15	CA15	410	13% Chromium steel
6	A 296, CB30	CB30	...	20% Chromium steel
7	A 296, CC50	CC50	446	28% Chromium steel
8	A 296, CF8	CF8	304	18-8 Austenitic steel
9	A 296, CF8M	CF8M	316	18-8 Molybdenum austenitic steel
10	.....	Cn-7MCu	...	A series of highly-alloyed steels normally used where the corrosive conditions are severe
11	.....	.....	...	A series of nickel-base alloys
12	.....	.....	...	High-silicon cast iron
13	.....	.....	...	Austenitic cast iron
14	.....	.....	...	Monel metal
15	.....	.....	...	Nickel

NOTE: ASTM — American Society for Testing Materials ACI — Alloy Casting Institute AISI — American Iron and Steel Institute

Materials for centrifugal pumps

MATERIALS FOR PUMPING VARIOUS LIQUIDS

Liquid	Condition	Material selection
Acid, acetic	Conc cold	8, 9, 10, 11, 12
Acid, hydrochloric	Comml conc	11, 12
Acid, nitric	Conc boiling	6, 7, 10, 12
Acid, sulfuric	>77%, cold	C, 10, 11, 12
Alcohols		A, B
Asphalt	Hot	C, 5
Beer		A, 8
Beet juice		A, 8
Brine, CaCl	pH>8	C
Brine, CaCl	pH<8	A, 10, 11, 13, 14
Brine, NaCl	<3%, cold	A, 6, 13
Brine, NaCl	>3%, cold	A, 8, 9, 10, 11, 13, 14
Calcium hypochlorite		C, 10, 11, 12
Carbon tet	Anhydrous	B, C
Formaldehyde		A, 8, 9, 10, 11
Gasoline		B, C
Glue	Hot	B, C
Lead	Molten	C, 3
Milk		8
Molasses		A, B
Mustard		A, 8, 9, 10, 11, 12
Oil, crude	Hot	3
Oil, fuel		B, C
Oil, kerosene		B, C
Oil, lube		B, C
Sewage		A, B, C
Soda ash	Hot	8, 9, 10, 11
Sodium hydroxide	Aqueous sol	C, 5, 8, 9, 10, 11, 13, 14
Sugar	Aqueous sol	A, 8, 9, 10, 11, 13
Tar	Hot	C, 3
Water, feed	Not evaporated	
	pH>8.5	C
	pH<8.5	B
	Evaporated, any pH	4, 5, 8, 14

Eight important factors affecting choice of materials for centrifugal pumps are: suspended-solids abrasiveness, corrosion resistance, electrochemical action, liquid temperature, head per stage, discharge pressure, structural considerations, pump load-factor.

Tables, *above and left,* summarize the broad experience of pump makers and users with various materials and liquids. Materials listed are applicable to all classes of pumps as far as corrosion-resistance characteristics are concerned. But in some pumps, design considerations impose differing physical requirements.

Obviously, a tabulation cannot recognize all possible construction variations but must concern itself primarily with the general problem of corrosion. This must be remembered when evaluating merits of the various materials.

Materials listed are those commonly used in the principal parts of the pump, such as casing, impeller, cylinders, etc. Trim items like sleeves, glands, rings, valves, etc, may differ to meet some mechanical requirement but the material selected should be suitable for the environment.

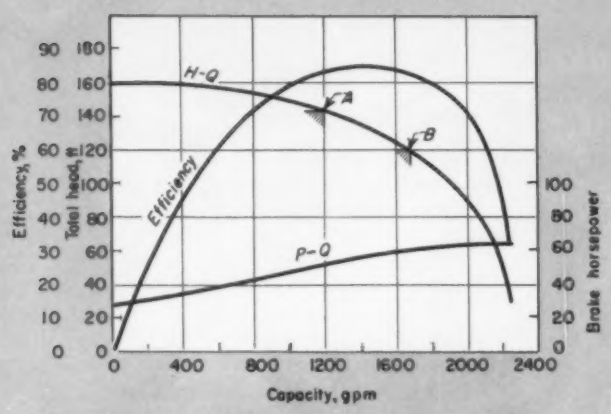
Because of the many variables, no one can say with certainty that some one material will best withstand corrosive attack of a given liquid. So more than one type is usually listed in the table, *left*. Order does not indicate relative superiority — factors predominant in one installation may be almost nonexistent in another.

Symbols used in table, *left,* are *A,* an all-bronze pump, *B* for bronze-fitted pumps, and *C* for all-iron pumps. Other materials, including a large number special corrosion-resistant types, are listed in table directly above.

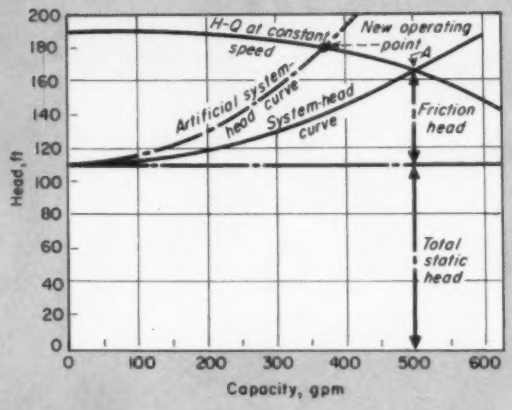
In *Standards of Hydraulic Institute,* par E-19, *Data Section,* a helpful form to aid the pump manufacturer select the best materials for a given liquid is presented. It is extremely useful to all prospective pump purchasers.

Bronze finds much use in centrifugal pumps because it doesn't rust, is easier to machine than iron, can be given a smoother finish and theoretically permits higher efficiencies. But its limitations may prevent its use.

Casings are cast iron in bronze-fitted and all-iron pumps. For corrosive, high-temperature and high-pressure jobs, others materials find use. Bronze casings are popular for mildly corrosive liquids, cast or forged steel for higher pressures and temperatures.



CHARACTERISTIC CURVES for a given impeller size and design show head, hp, capacity, efficiency



SYSTEM-HEAD curve is valuable tool for studying a given installation and hookup of its equipment

Centrifugal-pump and system curves

Unlike positive-displacement pumps (rotary and reciprocating), a centrifugal pump operated at constant speed delivers any capacity from zero to a maximum, depending on head, design and suction conditions. Characteristic curves, *above*, show interrelation of head, capacity, power and efficiency, for a specific impeller and casing.

It is usual to plot head, power and efficiency against capacity at constant speed, as above. But in special cases it is possible to plot any three variables against a fourth.

Head-capacity curve, labeled *H-Q*, shows relation between capacity and total head, and may be rising, drooping, steep or flat, depending on impeller type and design. At *A*, head is 144 ft, capacity 1200 gpm. At 120-ft head, *B*, the capacity rises to 1680 gpm.

System-head curve, *above*, is obtained by combining friction-head curve with static head and any pressure differences in pumping system. A friction-head curve is a plot of the relation between flow and friction in piping, valves

Drives for centrifugal pumps

Probably every form of prime mover and power source, with some kind of transmission if needed, has been used for driving centrifugal pumps. Today, electric motors drive most centrifugals. But steam, gas and hydraulic turbines, gasoline, gas and diesel engines, are also used.

Factors affecting drive choice include pump and driver rpm, service conditions, pump characteristics, availability and cost of power, physical details of the installation.

Driver speed may be limited to a certain band, as in diesel and gas engines. This band may be above or below ideal pump speed for job conditions. Where pump runs continuously, a speed increaser or decreaser is usually warranted. For units used only occasionally, as in standby service, a compromise pump design is often chosen, saving cost and complication of a speed changer. There may be some sacrifice in pump performance, and a higher cost.

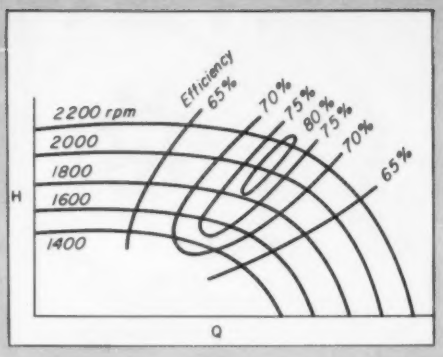
Electric motors for pump drive in the U. S. most often are full-voltage-starting ac units, though some dc motors find use. Generally, squirrel-cage motors are used, but synchronous and wound-rotor motors are also applied.

Recent development in *canned* and *axial-air-gap* sealed motors are almost certain to have a major influence in design of future small pumps. With some canned motors, p 101, straight-through flow is obtained, considerably simplifying piping connections. Axial air-gap motors shrink to almost pancake thickness, allowing easy installation and care. Both are leakproof, important in many process jobs.

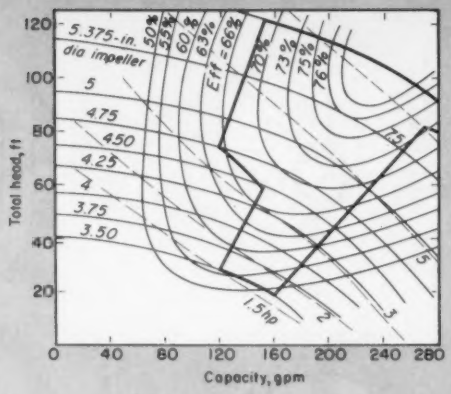
Canned motors appear to have a bright future in process and atomic-energy applications handling water at high temperatures and pressures. They also handle liquid metals.

The *electromagnetic* pump has no conventional driver. Instead, in the Faraday type, a heavy current is made to flow through the fluid (liquid metal), current entering the pipe wall through a brazed joint. Thus we're at the stage where raw energy, applied directly to the liquid, moves it from one point to another. In effect, we've bypassed one step present in pumping from earliest times—conversion of one form of energy into another in an impeller, piston, gears, etc.

Starting torque. Returning to today's more conventional practice, we find that normal-starting-torque motors are entirely adequate for starting centrifugals, even with discharge valve open. Starting torque from rest seldom exceeds



VARIABLE-SPEED head-capacity curves correlate head, rpm, efficiency and the capacity of the pump



PUMP CHARACTERISTICS when impeller diameter is varied within same casing find much practical use

and fittings in suction and discharge lines. Since friction head varies roughly as the square of the flow, a plot of it is usually parabolic. Static head is difference in elevation between liquid levels of suction and discharge.

Superimposing the pump H-Q curve on the system-head curve gives point A, the head and capacity at which the pump operates in that particular piping system.

Where a pump runs at more than one speed, a plot like that above shows complete performance for a given suction lift. To obtain this chart, H-Q curves are drawn for the speeds being considered. Then curves of points having the same efficiency are superimposed. These constant-efficiency curves, also called *isoefficiency* and *oak-leaf* curves, permit finding the required speed and the efficiency for any head-capacity condition.

Impeller diameter. Our first set of characteristic curves, *extreme left,* show performance for a specific impeller diameter, usually the maximum diameter. But impellers of more than one diameter can usually be fitted in a given casing. Curves above show performance of a given pump with impellers of various diameters. Heavy line encloses area of practical application of this particular design. Note how reduction in impeller diameter produces an effect similar to reduction in pump shaft speed in the previous curves. Tabulations of pump performance are made up by picking certain points from characteristic curves like those above.

15-20% of normal operating torque. It is usually highest in a sleeve-bearing pump that has been idle for some time.

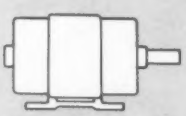
Overloading an electric motor is possible if pump horsepower increases with a change in capacity. But with a steam turbine, overloading is impossible because with a fixed throttle position, turbine speed is always a value such that pump torque equals turbine torque.

Internal-combustion engines may be rated for continuous load at rated speed, or for load at wide-open throttle, or for both. Most engines rated on continuous load will carry an overload. In any case, pump characteristics should be carefully studied before the driving engine is selected.

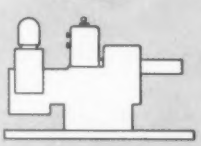
Variable-speed operation of centrifugals offers many advantages where varying capacity, head, or both, is needed. Since pump operating condition is fixed by crossing of its H-Q curve with system-head curve, *above,* only way to alter operating condition of a constant-speed unit is to change system head by throttling. On many jobs it is more practical and economical to vary pump speed.

An economic study is usually needed to decide between variable and constant speed for given service. Power saving of variable speed may be more than offset by higher cost to be written off over unit's life. In boiler-feed service, allow for useful heat from power losses of throttling.

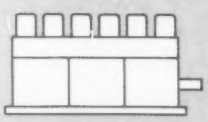
POPULAR PUMP DRIVES



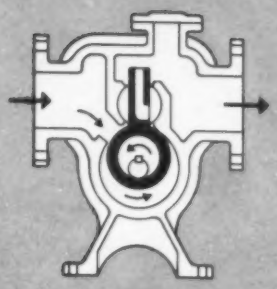
Motors, by far the most common drive today, are well suited to almost all industrial pumping jobs



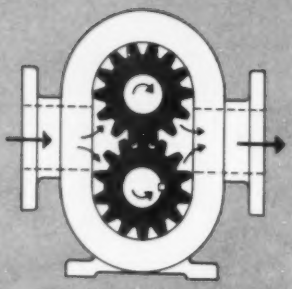
Steam turbines offer simple speed variation, can sometimes be used to improve plant heat balance



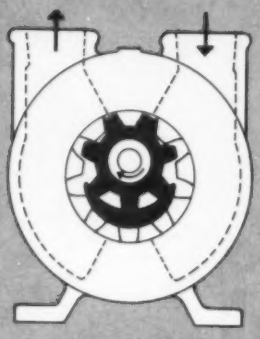
Internal-combustion engine drive is particularly popular for isolated service, also temporary



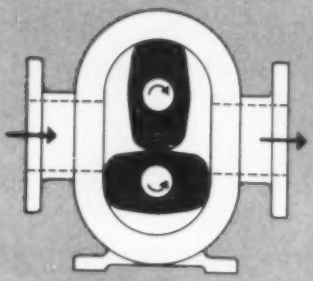
CAM-AND-PISTON



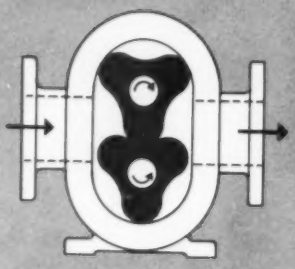
EXTERNAL-GEAR



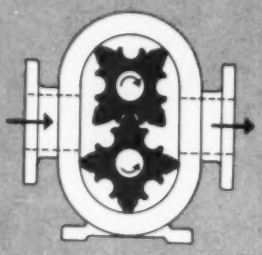
INTERNAL-GEAR



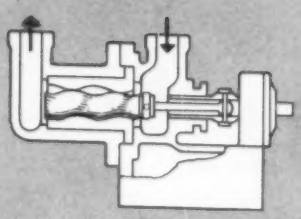
TWO-LOBE



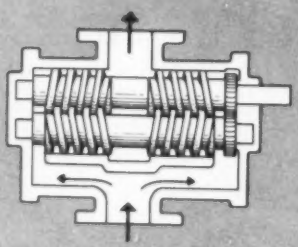
THREE-LOBE



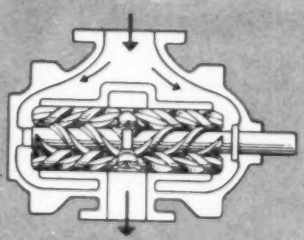
FOUR-LOBE



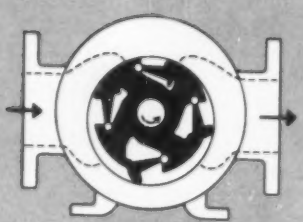
SINGLE-SCREW



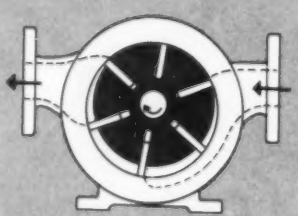
TWO-SCREW



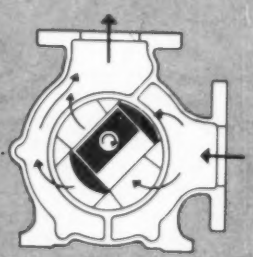
THREE-SCREW



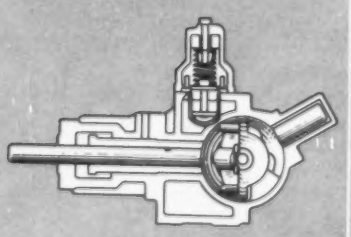
SWINGING-VANE



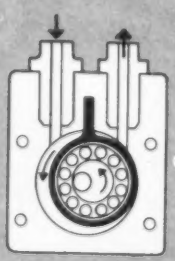
SLIDING-VANE



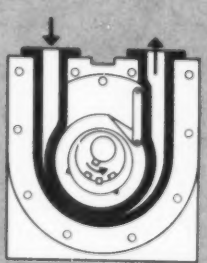
SHUTTLE-BLOCK



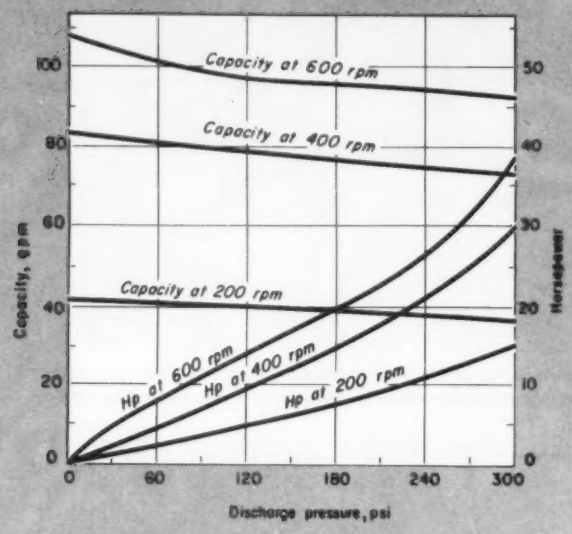
UNIVERSAL-JOINT



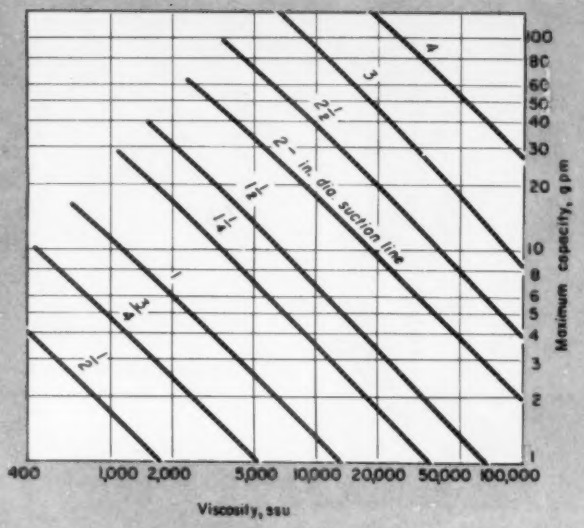
ECCENTRIC IN FLEXIBLE CHAMBER



FLEXIBLE-TUBE



CAPACITY and horsepower performance curves of a gear-type rotary pump handling heavy fuel oil. Note the flat *H-Q* curves



RECOMMENDED SIZE of suction piping for viscous liquids in 10 ft of straight pipe with two elbows and one gate valve

Rotary pumps

Rotary pumps, usually positive-displacement units, consist of a fixed casing containing gears, vanes, pistons, cams, segments, screws, etc, operating with minimum clearance. Instead of "throwing" liquid as in a centrifugal, rotaries trap it, pushing it around the closed casing, much like reciprocating pumps. But unlike a piston pump, a rotary discharges a smooth flow.

Fifteen designs, *left*, illustrate a few of the devices chosen to move fluids from one point to another. Often thought of as viscous-liquid pumps, rotaries are by no means confined to this service alone. They'll handle any liquids from A to Z, if free of hard solids. And hard solids can be handled if steam jacketing will melt them. As with centrifugals, materials and drives vary with job, liquid, etc.

Cam-and-piston pumps, also called rotary-plunger type, consist of an eccentric with a slotted arm at its top. Shaft rotation causes eccentric to trap liquid in casing, discharges it through slot to outlet.

External-gear pumps are the simplest rotary type. Liquid first fills the spaces between gear teeth as they separate on suction side, is then carried around and squeezed out as the teeth mesh. Gears may have spur, single- or double-helical teeth. Some designs have drilled idler to cut internal thrust.

Internal-gear pumps have one rotor with internally cut teeth meshing with an externally cut gear idler. Crescent-shaped partition, to prevent liquid from passing back to suction side, may or may not be used.

Lobular pumps resemble the gear-type in action, have two or more rotors cut with two, three, four or more lobes on each rotor, synchronized for positive rotation by external gears.

Single-screw pumps have a spiraled rotor turning eccentrically in an internal-helix stator or liner. Rotor is metal while helix is hard or soft rubber.

Two- and three-screw pumps have one or two idlers, respectively. Flow is between the screw threads along the axis of the screws. Opposed screws may be used to eliminate end thrust.

Swinging-vane pumps have a series of hinged vanes which swing out as the rotor turns, trapping liquid and forcing it out the discharge pipe.

Sliding-vane pumps use vanes that are thrown against casing bore when rotor turns. Liquid trapped between two vanes is carried around and forced out the discharge.

Shuttle-block pump has a cylindrical rotor turning in a concentric casing. In the rotor is a shuttle block and piston reciprocated by an eccentrically located idler pin, producing suction and discharge.

Universal-joint pump has a stub shaft in free end of rotor supported in a bearing at about 30 deg with the horizontal. Opposite end of rotor is fixed to drive shaft. When rotor revolves, four sets of flat surfaces open and close for a pumping action of four discharges per revolution.

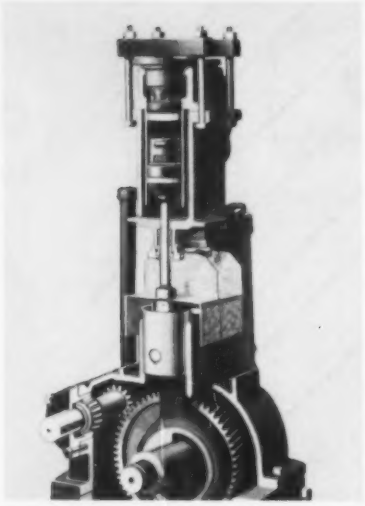
Eccentric in flexible chamber produces pumping action by squeezing the flexible member against pump housing to force liquid out discharge.

Flexible-tube pump has a rubber tube squeezed by a compression ring on an adjustable eccentric. Pumps of this design are built single- and 2-stage.

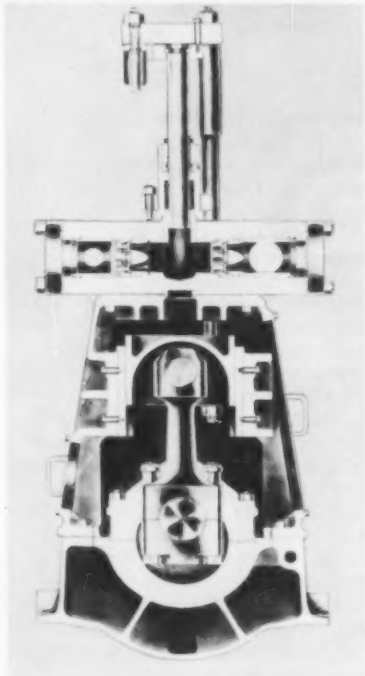
Characteristic curves, *above left*, for a typical rotary gear pump show the flat *H-Q* relation obtainable. Displacement of a rotary varies directly as speed, except as capacity may be affected by viscosity and other factors. Thick liquids may limit pump capacity at higher speeds because they can't flow into casing fast enough.

Slip or loss in capacity through clearances between the casing and rotating element, assuming a constant viscosity, varies as pressure increases. For example, in above curves, capacity at 0 discharge pressure is 108 gpm. But at 300 psi and same speed, capacity is 92 gpm. Difference is slip.

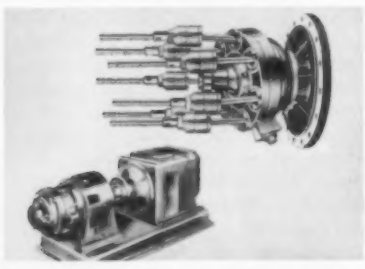
Power input to a rotary increases with liquid viscosity; efficiency decreases. This is true, of course, with other classes of pumps. But since rotaries find wide use for viscous liquids, it is wise to use the chart, *above right*, for sizing suction lines to prevent excessive friction loss.



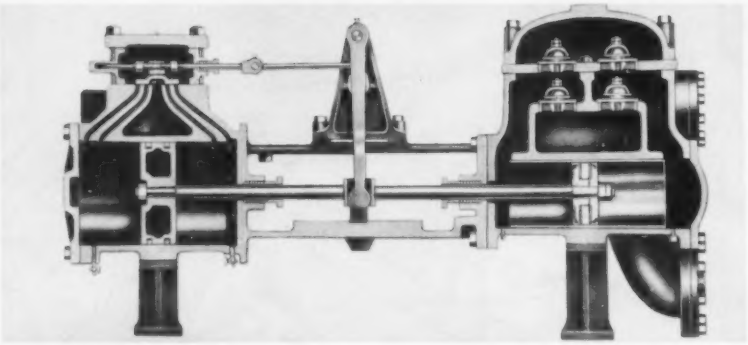
SINGLE-ACTING vertical-type power pump has pinion shaft for driving crankshaft



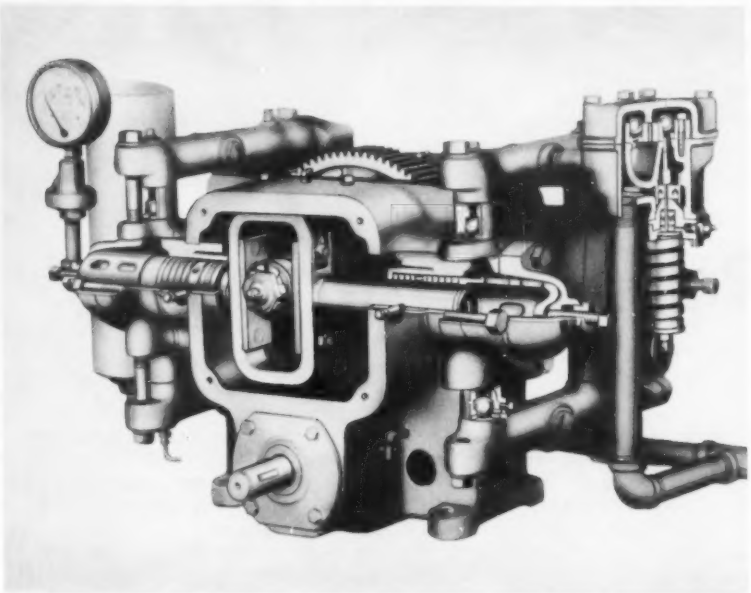
INVERTED triplex vertical-plunger power pump for high-pressure job applications



ROTARY-PLUNGER single-acting pump unit has five or seven plungers in a circle



DIRECT-ACTING horizontal duplex piston pump. Steam end is at left, liquid end is at right. Piston-rod motion shifts steam valve for admission and exhaust of the steam



QUADRUPLEX horizontal-plunger power pump for high pressures is motor driven through pinion and gear. Each Scotch yoke drives two plungers. Pump valves are the ball type

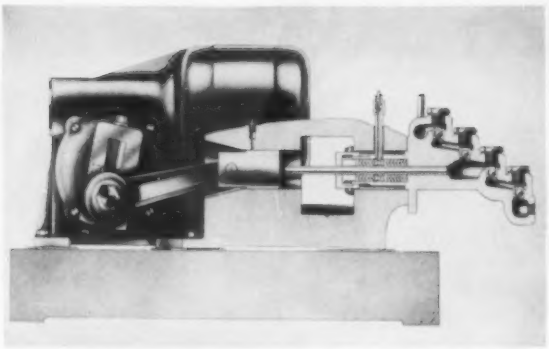
Reciprocating pumps

The 13 pumps on these two pages are but a few of the many reciprocating types in regular use today. But you will find shown here most of the major designs.

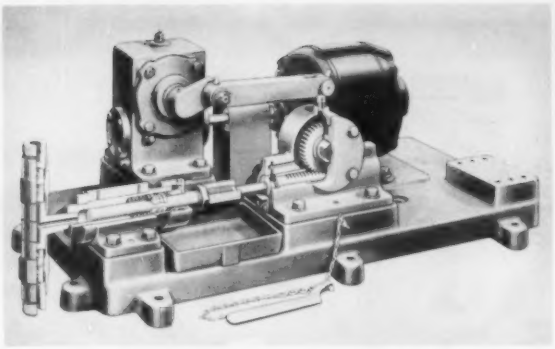
Reciprocating pumps, unlike centrifugals, p 80, are more often classed according to type, rather than use. Perhaps this is because their ultimate use is less clearly defined than for centrifugal pumps. While certain applications for this type, like fuel-oil pumping, are declining, others, like boiler and chemical feeding, are rising.

Biggest recent developments are in non-geared higher speed power pumps — both large and small units. Adjustable displacement pumps, also called metering and proportioning or controlled-volume, are being improved every year to give wider capacity ranges, greater accuracy, easier control.

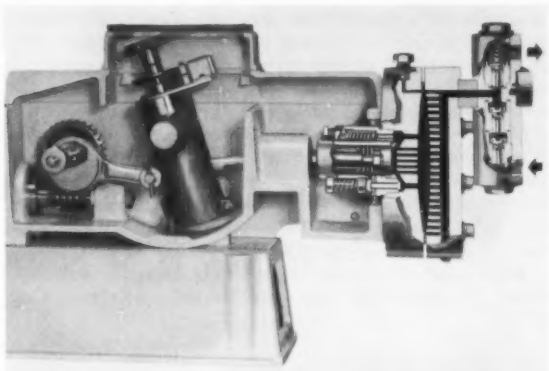
Power pumps, always of importance in the marine field for boiler feed are finding some new berths in stationary plants for the same service where loads justify them. And if pressures in super-pressure plants rise, it is likely that power-type reciprocating pumps will be used for boiler feed. Of course, much depends on new developments in the design of centrifugal pumps.



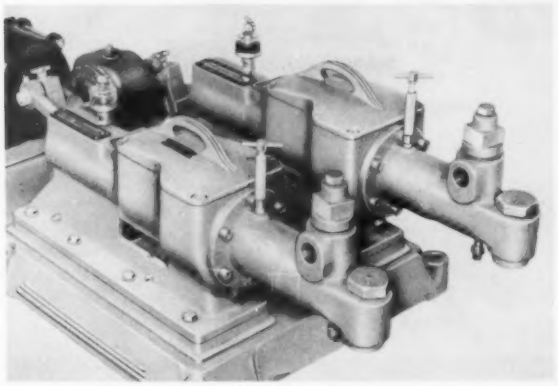
CONTROLLED-VOLUME plunger pump has screw adjustment of stroke length. Change of crankpin position alters capacity of pump



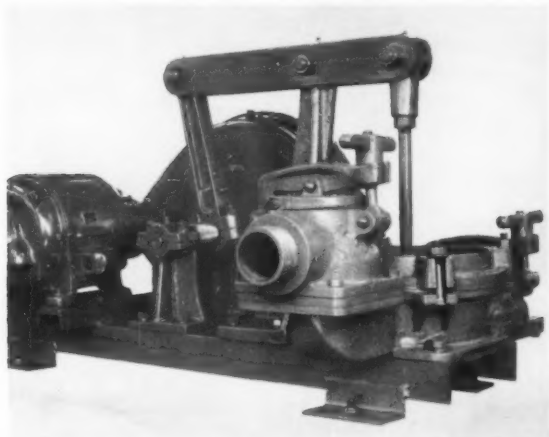
METERING and proportioning plunger pump has lost-motion type of coupling for adjusting stroke length and capacity of pump



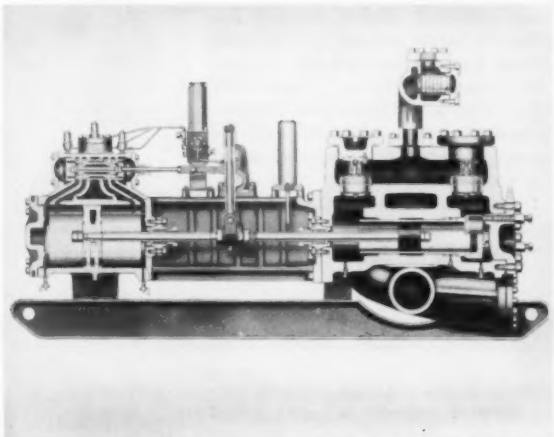
PISTON-DIAPHRAGM unit for controlled-volume pumping has oil for actuation of diaphragm which pumps the liquid handled



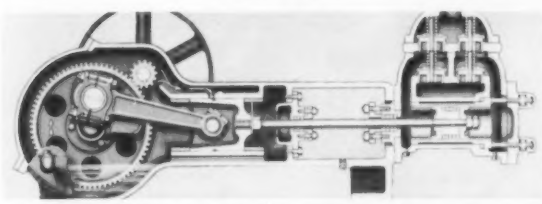
DUPLEX plunger-type feeder pump has micrometer adjustment of stroke length by means of variation of the crankpin position



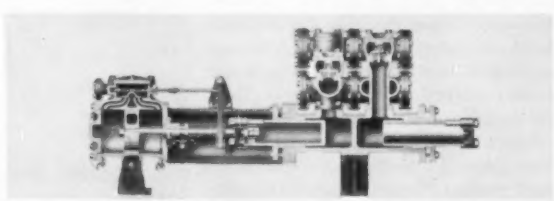
DIAPHRAGM pump with ball suction and discharge valves is built with stationary or movable base, is motor driven through beam



DUPLEX STEAM slush pump has divided-cylinder pot-type liquid end with suction manifold at the bottom of the liquid cylinder

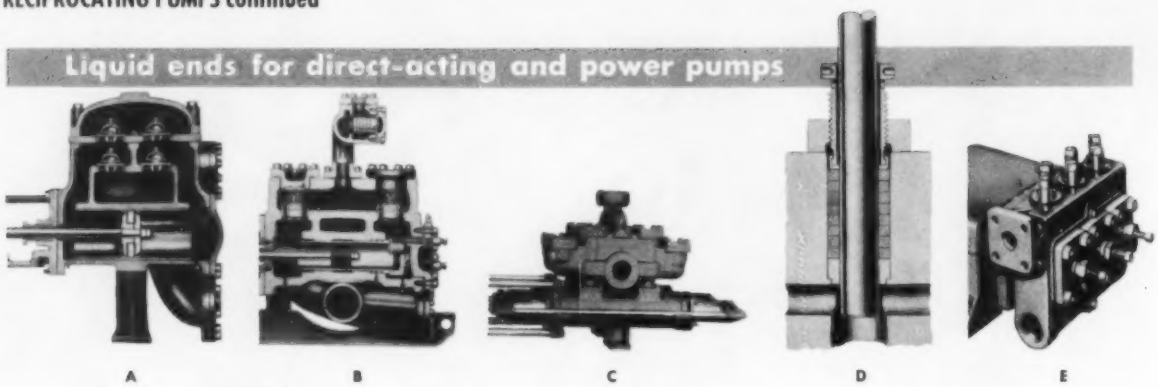


HORIZONTAL SIMPLEX power pump is driven by pinion geared to crankshaft, has disk-type suction, discharge valves, air dome



HORIZONTAL DUPLEX outside-end-packed pot-valve-type plunger pump: the plungers shown are attached together by the tie rods

Liquid ends for direct-acting and power pumps



Reciprocating-pump liquid ends are built in a large number of designs for various liquids, service conditions and pressures. Shown above are a few typical arrangements for modern pumps.

Direct-acting steam pump, *A*, often has *valve-plate* liquid end with removable discharge-valve decks. Cup-type packing for liquid piston is also shown. *Valve-pot* type, *B*, has valve chambers closed by individual covers. *Outside-packed* plunger pump, *C*, has its valves in pots—all packing leakage is external where it can be seen.

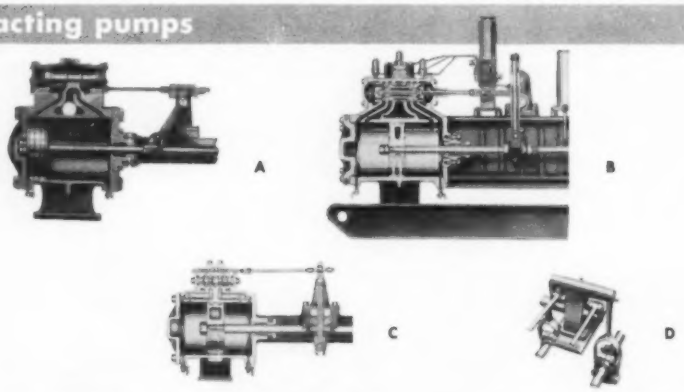
Vertical power pump, *D*, has plunger packing at cylinder top, while horizontal triplex pump, *E*, has it in the usual location with valves above and below plunger. At *F*, valves are in step arrangement. Another design for a vertical triplex pump appears at *G*. Liquid-end design is a function of pressure developed, liquid handled, capacity, etc.

Steam ends of direct-acting pumps

Flat or 'D' slide valves find use for steam pressures of 200 psi and less Balanced piston valves are common in large high-pressure pumps.

Flat valve, A, is thrown by auxiliary piston. Motion is regular and positive. *Balanced-piston valve, B,* runs in sleeve, has minimum friction, long life. *C* is another *balanced-piston* valve.

Typical steam-valve linkage, *D,* connects to rod. Steam-end design of vertical pumps resembles those shown.

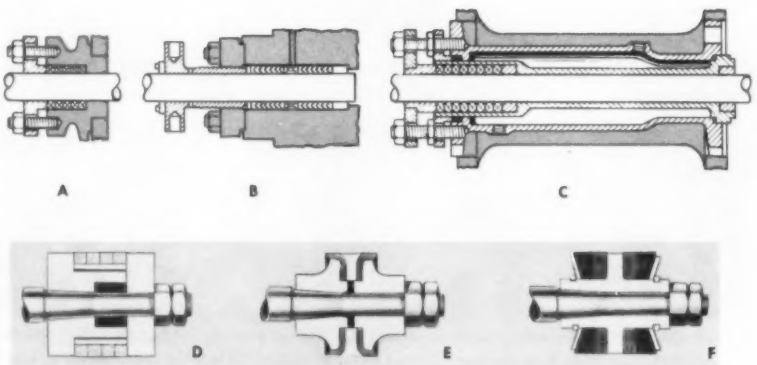


Packing

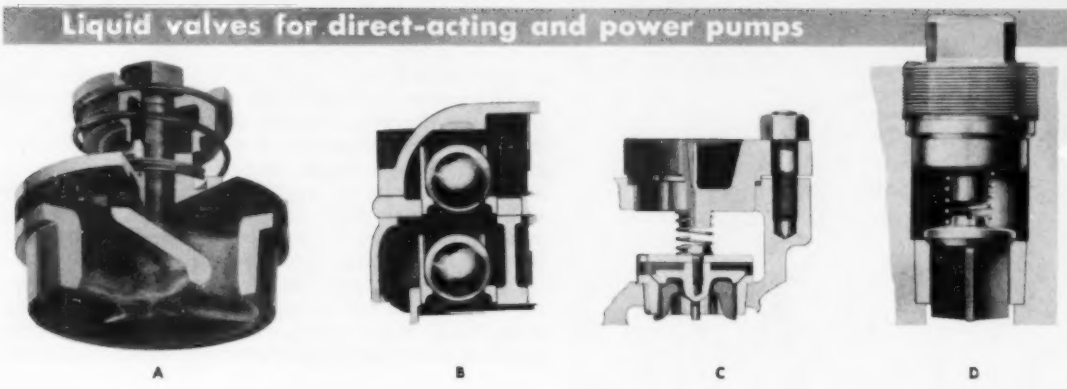
Packing is any material used to control leakage between a moving and stationary part in a pump. Flexible, and usually soft, it is expendable.

Simple piston-rod stuffing box, *A,* has several rings of square packing. On small rods a single nut surrounds gland, instead of studs shown. *Chevron* packing, *B,* is often used. Sketch shows plunger of high-pressure pump. *C* is a jacketed stuffing box.

Piston packing takes many forms. *Duck-packed* piston, *D,* is for bronze-fitted general-service pump. *Cup* packing, *E,* is standard for oil pumps. *Solid rubber rings, F,* are also popular.



Liquid valves for direct-acting and power pumps

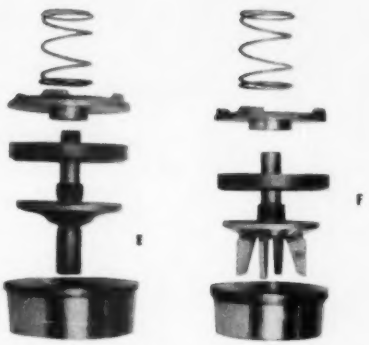


A B C D

As a general rule, stem-guided disk valves are used for low-pressure jobs, wing-guided (flat- or bevel-faced) for moderate pressures, and bevel-faced wing for high pressures. But much depends on liquid, etc.

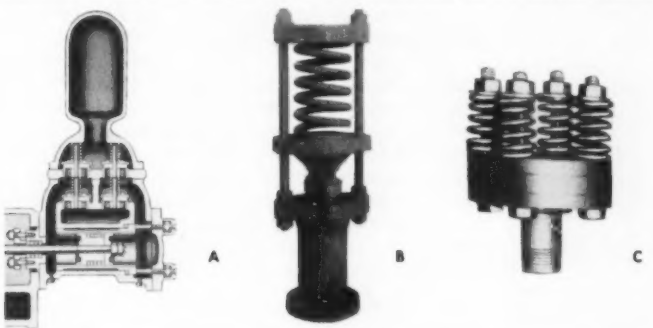
Flat disk, A, has inclined ribs in seat to direct liquid so it rotates disk slightly at each stroke. *Ball valve, B,* often finds use where free opening for thick liquid is desired. Cage guides ball during its rise and fall. Seat is circular and completely open. *Wing-guided* valve, *C,* for thick gritty liquids, can be fitted with renewable rubber inserts for wings. Another design, *D,* for high-pressure clear liquids, has renewable seats.

Low-pressure valve, *E,* and *high-pressure* valve, *F,* for thick liquids are alloy-steel with synthetic inserts for all ordinary services. Special materials are used where corrosive liquids are to be handled. Double-ported ring-type valves, *G,* p 92, are popular in large power pumps.



E F

Cushion chambers and pressure alleviators

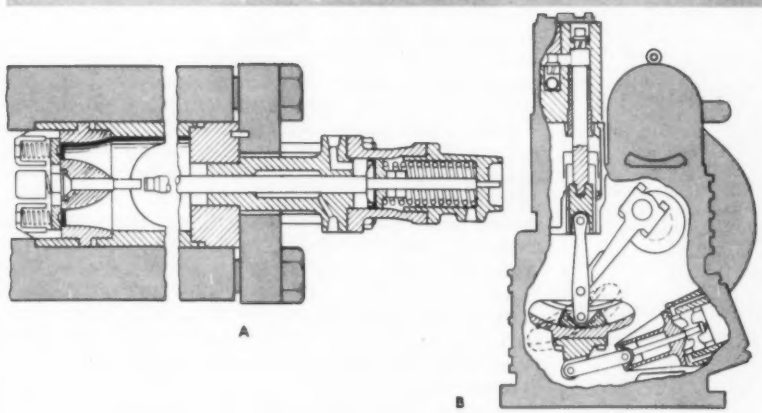


A B C

Suction and *discharge cushion chambers* smooth liquid flow. Discharge chamber, *A,* is often built as part of pump while suction chamber may be part of pump or in adjacent piping.

Pressure alleviators, *B* and *C,* find use with high-pressure power pumps to absorb shock from sudden stopping of liquid. They usually consist of a spring-loaded plunger operating in a stuffingbox. Liquid does not escape from piping system during surges.

Variable-capacity devices

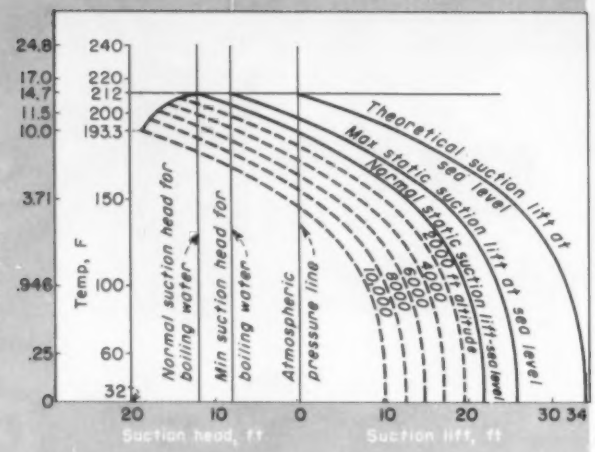


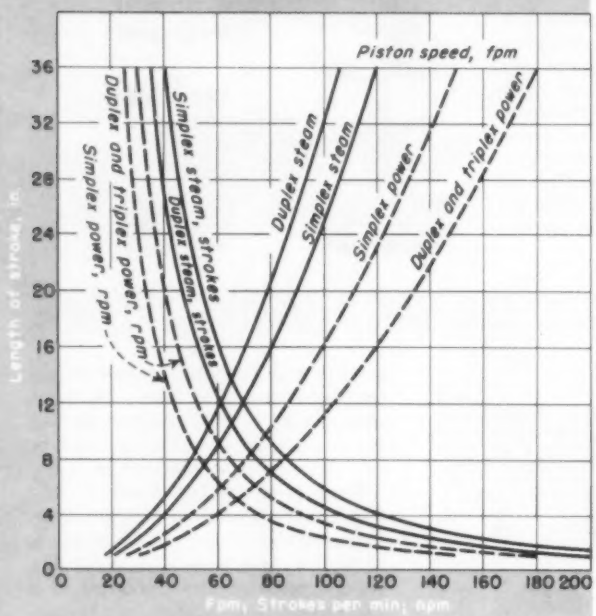
A B

There seems no end to devices for varying capacity of small reciprocating pumps. A few appear on pp 90-91. For large power pumps, however, not so many variations exist perhaps because of the lesser number of designs.

Suction-valve unloader, A, gives a quick but gradual reduction in liquid delivery from full to zero flow in not more than one-half revolution of pump. It increases liquid delivery in same way, is pneumatically actuated.

Stroke-transformer, B, can automatically or manually vary plunger motion from zero to maximum stroke. Output is infinitely controllable.





Suction lift

Recommended total suction lift is 22 ft for slow-speed reciprocating pumps handling cold water at sea level. High-speed pumps usually aren't capable of lifts that high. Curves, *left,* show effect of altitude and temperature on lift of a 6x4x6-in. valve-plate-design duplex direct-acting pump.

Maximum theoretical suction lift of a pump is 34 ft. of cold water at sea level. Difference between this and the practical lift represents losses in valves, pipe friction, velocity head and various entrances in the system.

Other factors affecting practical lift include pump type, and design of suction valves, pistons, plungers, suction passages, liquid vapor pressure. So limits shown in curves should be taken only as illustrative of one particular design.

Capacity and speed

Reciprocating pumps don't suck in liquids; they reduce pressure in the suction chamber and external pressure, usually atmospheric, pushes liquid into the pump. For any pump with a given size suction line, capacity or maximum speed is fixed by existing *net positive suction head* (npsh).

As speed of a reciprocating pump rises, so does its capacity, provided nothing interferes with flow into and out of pump. Curves, *left,* show basic speeds for direct-acting and power pumps. For former, speed is expressed in feet per minute piston motion; for latter, either as piston speed or rpm.

Viscosity and temperature of liquid pumped also influence maximum pump speed and capacity. Thus, as viscosity of liquid changes from 250 to 5000 ssu (table at left) pump speed falls from rated to about 65% of rated. As temperature rises from 70 to 250 F. we have a similar speed decrease to 62% of rated.

Semi-solids, like acid sludge, molasses and syrup, are handled in reciprocating pumps designed to run without a suction valve. Either ball or disk discharge valves are used.

When considering a given pump, check with its maker to determine exact effects of viscosity, npsh, temperature and design on capacity. Generalizations, while helpful guides, must not be used too freely. Table, *left,* summarizes speed correction factors for viscosity and temperature recommended by Hydraulic Institute. To use, simply multiply rated speed by percentage reduction, expressed as a decimal.

Speed correction factors

Liquid viscosity, ssu	250	500	1000	2000	3000	4000	5000
Speed reduction, %	0	4	11	20	26	30	35
Liquid temperature, F	70	80	100	125	150	200	250
Speed reduction, %	0	9	18	25	29	34	38

Approximate efficiencies — direct-acting pumps

Stroke, in.	5	8	10	20	30	40	50
Crank-and-flywheel pump				87	88	90	92
Piston pump	60	70	74	84	86	88	90
High-pressure pump	55	64	67	76	78	80	81

Approximate efficiencies — power pumps

Water hp	3	5	10	20	30	50	75	100	200
Efficiency, %	55	65	72	77	80	83	85	86	88

Efficiency

As with any machine, efficiency of a reciprocating pump varies with size, design, application, etc. Though it is risky to generalize about pump efficiencies, tables, *left,* summarize typical ranges for direct-acting and power pumps.

Leakage past pistons, stuffing boxes and valves, expressed in percentage of liquid - piston displacement is *slip,* and equals 1— volumetric efficiency, expressed as a decimal. Slip in new pumps is about 2%; in some low-head designs it may be as low as 0.5%. Where inertia of liquid column is high slip may be negative.

Efficiency given in the tables is sometimes referred to as *gross* efficiency for direct-acting pumps, and is the ratio of pump output in water or liquid horsepower to the power input. Latter is indicated horsepower of a direct - acting steam pump or brake horsepower of a power pump.

While pump efficiency is always of interest, its relative importance depends much on pump capacity, service, etc.

Liquid-end characteristics

Discharge of centrifugals and most rotaries is steady. But with reciprocating pumps it pulsates, character depending on pump type and whether or not it has a cushion chamber.

Simplex direct-acting steam pumps at normal speed have a discharge curve like that at right. The flow is steady until end of stroke, where piston stops and reverses. Without an air cushion, flow theoretically ceases when the piston stops. But cushion prevents this, giving loops shown.

Duplex direct-acting pump, *right,* has discharge of one cylinder displaced half a stroke from that of other. The two add together to give solid line with twice as many valleys as simplex, but low points are never below those of simplex.

Power-pump discharge curves, *right,* take form of sine waves because pistons or plungers are crank-driven. Discharge flow doesn't change as abruptly as with direct-acting pumps.

Simplex double-acting power pump for which curve is plotted has maximum flow rate 60% above average; minimum below average is 100%. This means that at a point during each pumping cycle, flow from pump is zero. But flow from the discharge line may be nearly constant, depending on job; physical conditions and piping layout.

Duplex double-acting power pump gives us the second curve shown, *right.* Here maximum flow rate is 26.7% above average; minimum is 21.6% below average. Thus, we always have flow in discharge pipe while pump is running.

Triplex single-acting pump further smooths discharge curve, as shown. Maximum flow rate above average here is 6.64%; minimum below is 18.4%. With any reciprocating pump, difference between maximum discharge and average quantity is stored in cushion chamber until discharge drops below average.

Quintuplex and septuplex power pumps smooth the discharge curve even more, to give practically constant discharge-line flow. Ultimate test of discharge-curve suitability is the job itself. Large pulsations may be of minor importance in one installation, yet in another they may be the major consideration.

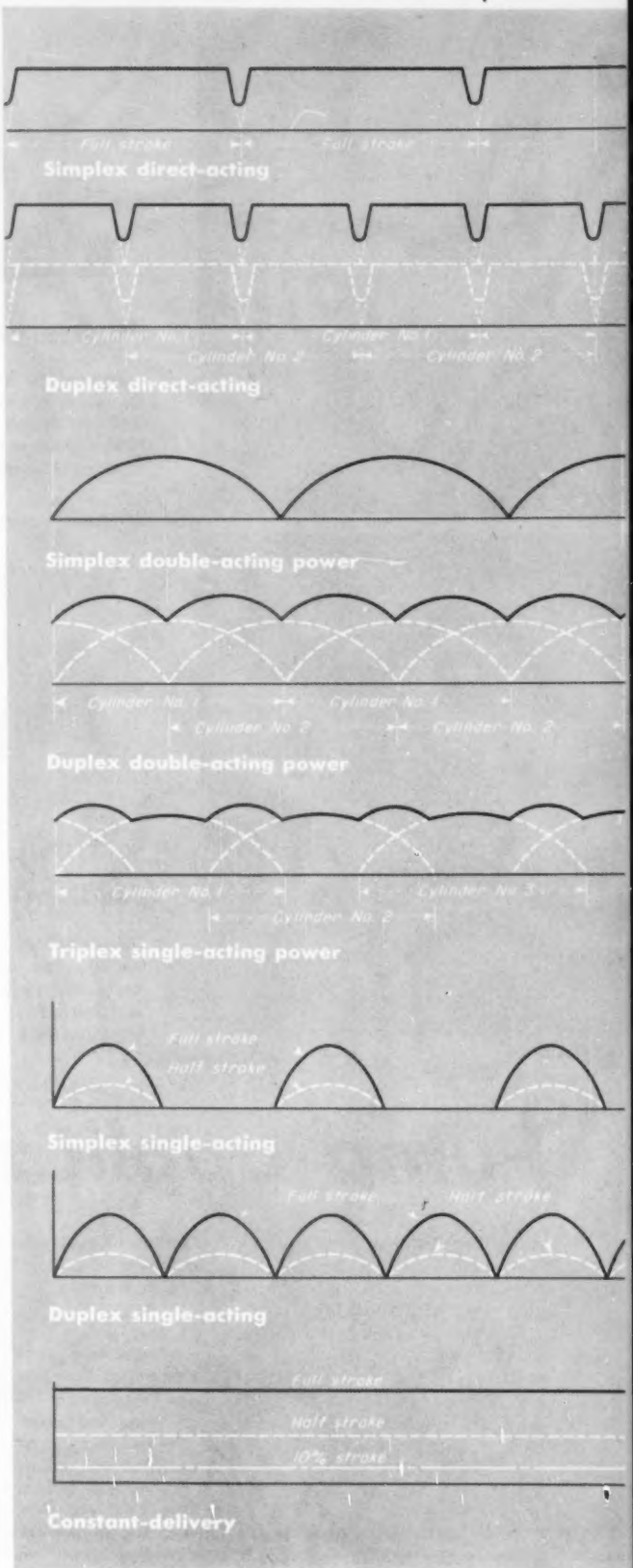
Variable-capacity pumps resemble, to a certain extent, their bigger brothers when it comes to the discharge curve. But the fact that capacity can be changed as desired alters the appearance of the curves somewhat.

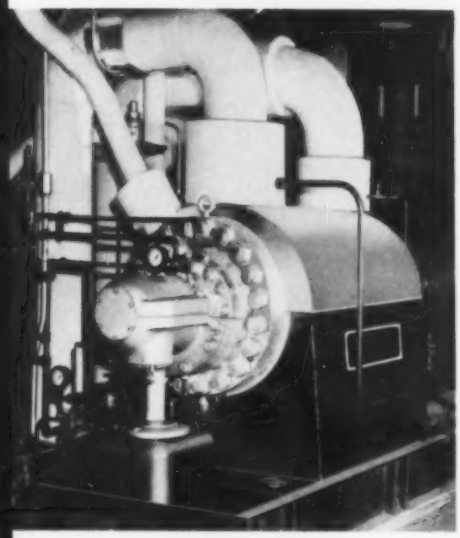
Simplex single-acting pump has pulsating flow shown at right, with no discharge during suction. When the capacity is decreased, the sine-type curve becomes flatter, as shown.

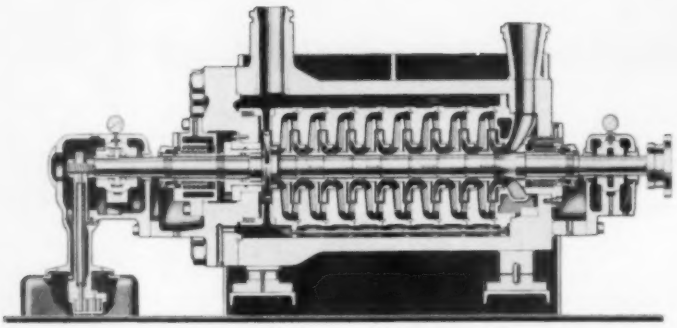
Duplex single-acting designs deliver twice as much liquid, and have discharge curves similar to simplex units. But when one piston stops delivering liquid, the other starts, if pistons are 180 deg apart, as shown at right. So we have no lengthy periods of zero flow from the pump.

Where constant delivery is desired without pulsation, a discharge curve like that at bottom right can be obtained by using a special design for this service. Note here how the curve is flat throughout, whether the pump runs at full stroke, half, or less.

Once again it is important to remember that the discharge curve of a reciprocating pump is not a measure of its efficiency, but simply a graphical representation of what is happening in the pump discharge. The final measure of the importance of the curve shape is the job requirements.

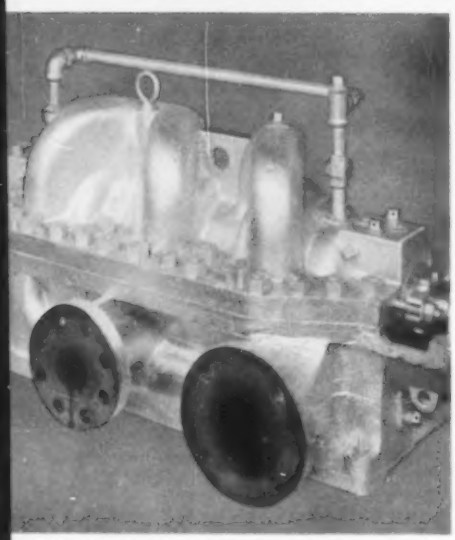


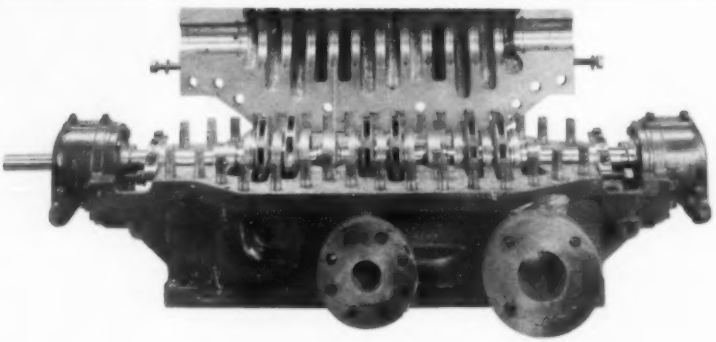




High-pressure boiler feed

The modern double-case barrel-type centrifugal pump is today's answer for pressures approaching 6000 psi and temperatures to 1000 F. In the common 2600-psi range, units of this type run at about 3600 rpm, have up to 12 stages. The first superpressure plant uses two pumps of this type in series, with heaters between. Note how vertically split inner assembly is housed in casing.





Medium- and high-pressure boiler feed

Horizontal split-case diffuser-type pumps with about six stages are common for 3600-rpm duty at pressures to 1600 psi. Some thinking today sees these units applied up to 2500 psi, but that is in the future. Design shown is 6-stage with back-to-back impellers in groups of two for better hydraulic balance. A big advantage of this type of pump is easy removal of top for maintenance.

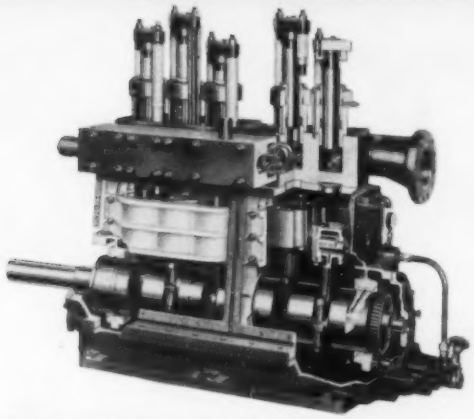
Pump applications

Any attempt to list every possible application of pumps is almost certain to run aground because editors, being human, might overlook important jobs like pumping goldfish, apples, oranges, eggs and beer.

So these two pages, and the following four, give a necessarily selective cross section of pump classes and types *on the job*. There lies the ultimate goal of pump designers and builders—a product that performs a given service at the best over-all cost with minimum operating and maintenance needs. To secure these results the pump must be suited to the job, installed correctly, operated and maintained as the builder recommends. For now, let's take a quick look at application.

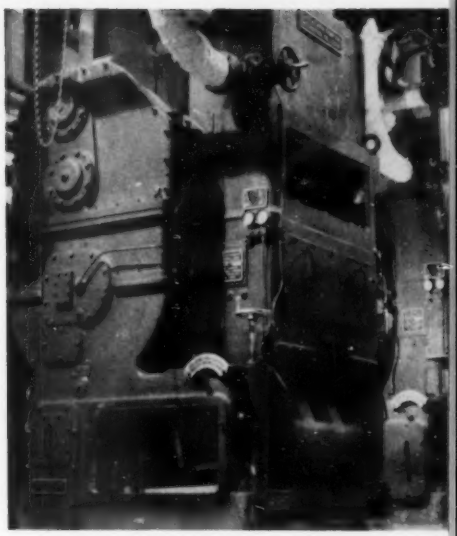
Pump class, type, drive and materials are among the major factors in unit selection. While generalizations are often dangerous, studies of a large number of modern installations show that industrial and service establishments throughout the U. S. use centrifugals for about 60% of their jobs, reciprocating for about 22%, rotary for about 12% and deepwell for about 6%. About 86% of the centrifugals have motor-drive, 44% of reciprocating, 96% of rotary and 95% of deepwell. Steam engines, turbines and internal-combustion engines drive about 13% of the centrifugals. Steam is outstanding for reciprocating units, driving almost half of those in use.

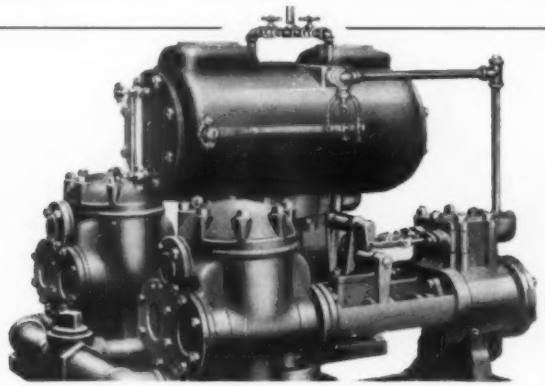
While these statistics are helpful from an over-all viewpoint, they serve merely as a guide to what industry is doing today. For help with a specific installation, the text and illustrations on these six pages will lead you through the maze of classes and types toward a sound answer.



Power reciprocating for boiler feed

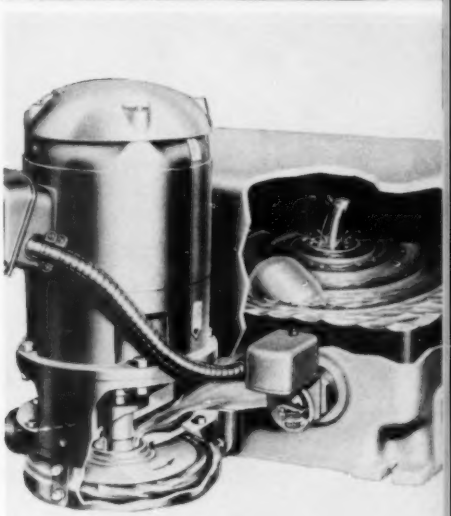
At pressures over about 250 psi where load is variable, power reciprocating pumps find application. They are also used for desuperheater feed in this pressure range. Vertical quintuplex units like that above are popular in feed service because they are easy to control automatically in stepless straight-line fashion from 0 to 100% of rated capacity. Use is now on the upswing.

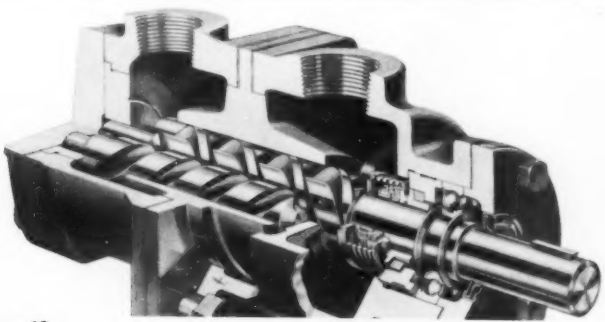




Low-pressure boiler feed

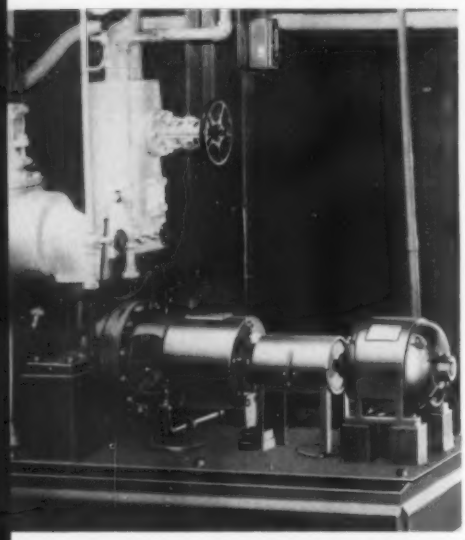
Direct-acting pumps, with or without receiver, find use in smaller low-pressure boiler installations. Simple, rugged and economical, they give outstanding service. Though not always classed as feed pumps, centrifugal condensation sets, *right*, are extremely popular in heating and similar installations. Compact and efficient, they handle wide temperature, pressure, capacity ranges.

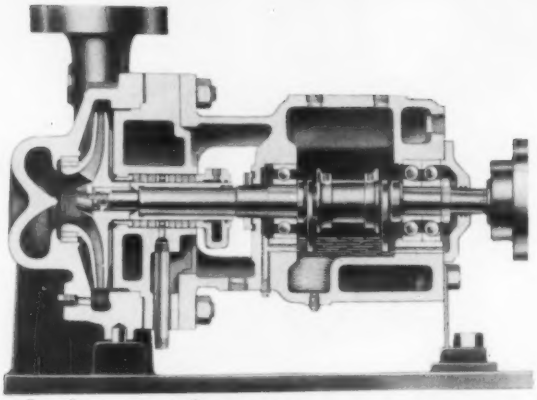




Fuel oil

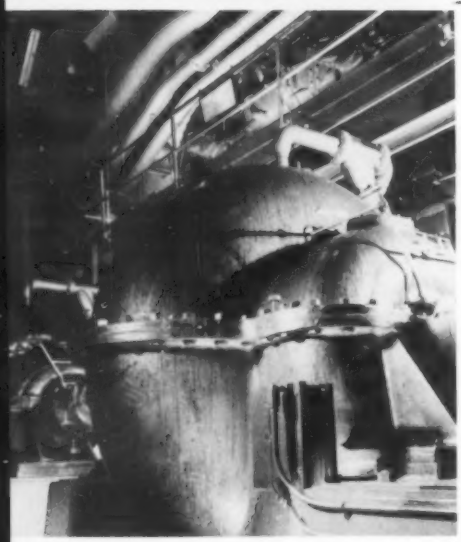
Screw and gear pumps are the modern units for fuel-oil pumping but direct-acting steam pumps still do the job in some plants. Screw pump shown handles up to 80 gpm at continuous pressures of 275 psig, intermittent to 325 psig. Pumps of this type find many other uses besides fuel-oil pumping, including lubrication, booster, circulating, governing and elevator jobs.

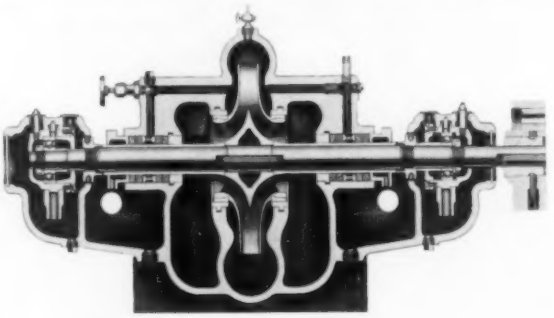




Heater drains, condensate

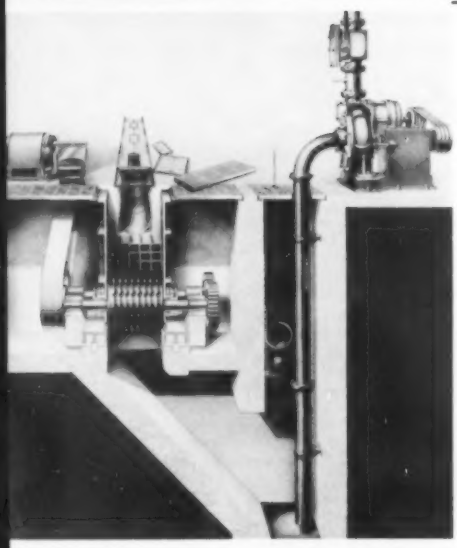
Handling condensate from hotwells, heater drains and other sources may impose severe operating conditions on a pump. In condenser service, suction head is low, liquid is near the boiling point, suction seal is a minimum and load changes wide. Usual centrifugal condensate pumps have one to four stages, special sealing and balancing features. Unit shown is single-stage.

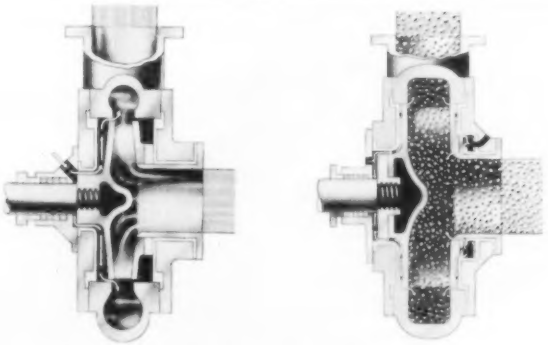




Cooling water

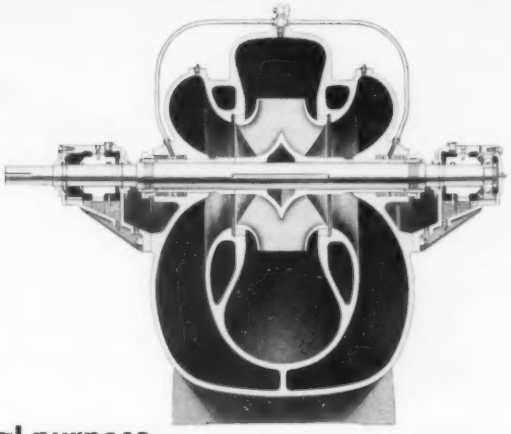
Whether tremendous, like the 55,000-gpm unit at left, or tiny as those on a small air conditioner, cooling-water pumps have some common traits. They are usually single-stage, standard-fitted, split-case. In the larger capacities they are often horizontal units, though many vertical designs are also used, both large and small. Their duty is seldom severe; operation is trouble-free.

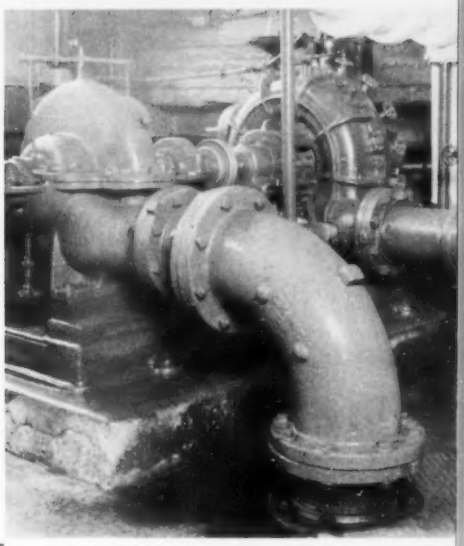




Handling ash, abrasive solids

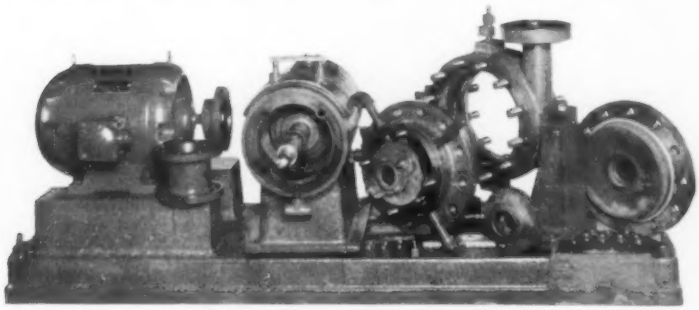
In contrast to cooling-water service, handling abrasive solids of any kind imposes many special problems on a pump. Rubber-lined units with special seals, as shown, are one good answer for ashes, sand, etc. Other designs include packingless types, flat-blade impellers and special arrangements for suction inlet. While the pump is important, so are other system details.

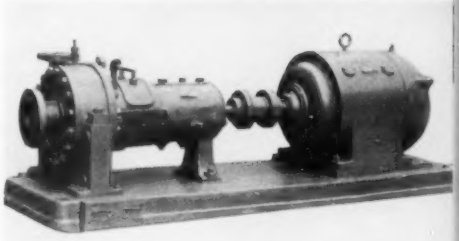


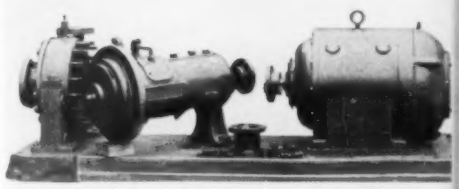


General purpose

This term applies to all classes of pumps, but centrifugal designs in this category perhaps outnumber all others. Usual meaning of term is a pump to handle clear cool liquids at ambient or moderate temperatures. Often single-stage, these units may be split-case, and are standard-fitted pumps equally good for a number of services. Some handle liquids with solids.

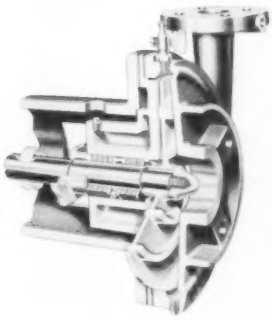


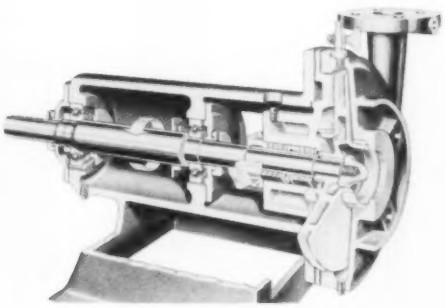


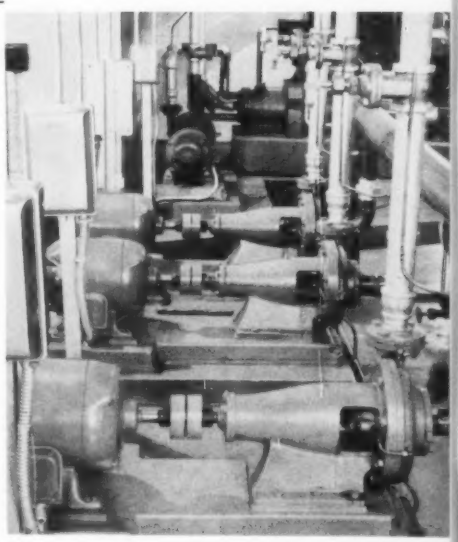


General process work

In recent years engineers have developed special process-pump designs featuring accessibility, good efficiency and long life. Some designs are available as part of a standard line whereas others are made up to suit the particular service conditions for a specific job. As these illustrations show, ease of maintenance is a prime consideration; complete disassembly is simple.

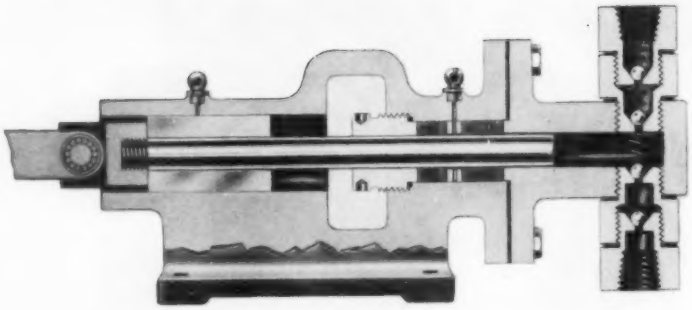






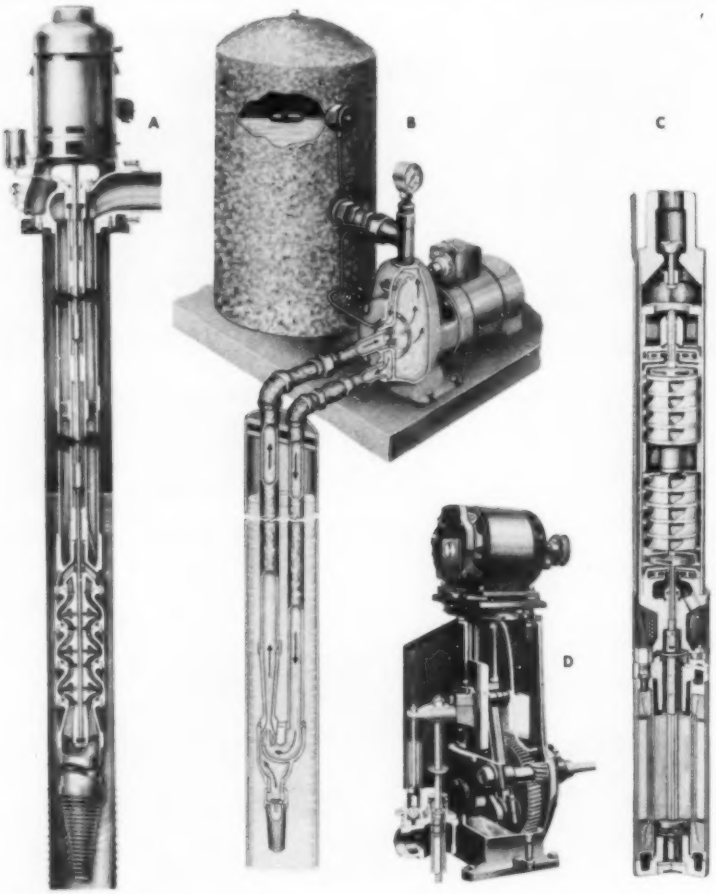
Chemical process

Outwardly resembling the general process pump, units designed for chemical service may differ markedly in materials, stuffing boxes, seals, etc. Usual aim is to produce a single pump line that comes as close as possible to being able to serve all process needs in the chemical industry. Usual units are horizontal, with radially split casings. They can handle a wide range of chemical liquids.



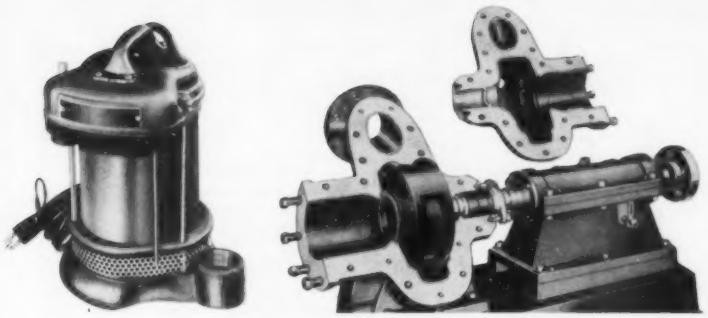
Chemical feed

Requiring easy adjustment of capacity, chemical-feed pumps are built in a large number of different designs. Unit shown has its reciprocating pumping elements arranged for accessibility. Suction and discharge valves are ball type. Other designs used for chemical feeders are shown on pp 90, 91 of this handbook. For more, see POWER, July 1952; July, Aug, & Sept 1953.



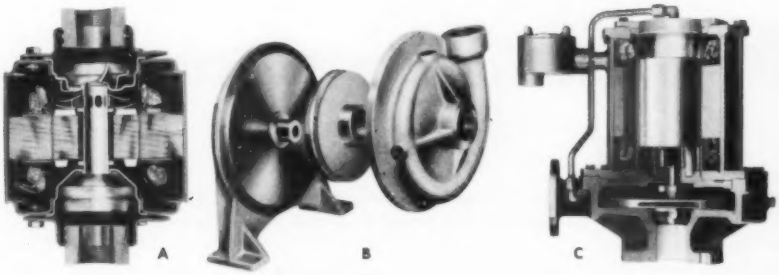
Well-water supply

Water, like gold, is where you find it. Often this is deep in the earth. So we find many designs for this service. *Deepwell* pump, *A*, often called a *turbine* pump, is a multi-stage diffuser unit. *Jet pumps*, *B*, bypass a portion of their discharge to an ejector nozzle at the suction screen where it helps improve flow into pump. *Submersible*, *C*, has motor in well. *D* is *plunger* pump.



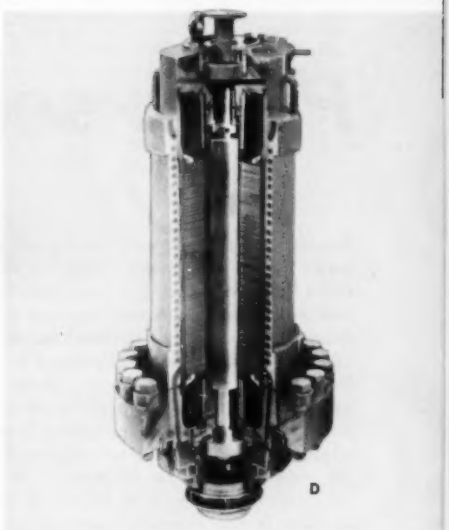
Sewage and sump

Centrifugal pumps for sewage usually have special non-clogging impellers and a casing that is easily opened for unit inspection, *above right*. Sump pumps, *left* and *extreme right*, may be portable or permanent, depending on needs of the installation. Impeller is almost always the non-clogging type to prevent solids from catching in it. Automatic control is practically universal.



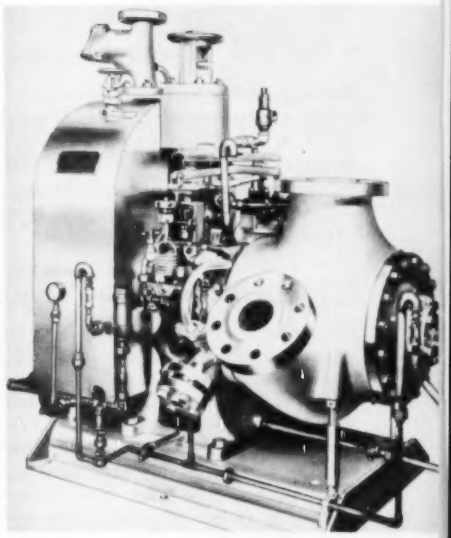
New and special services

Developed in '30s for hot-water circulation, and later refined for chemical and nuclear-power jobs, canned pumps are now strongly bidding for industrial jobs where leak-free service and minimum maintenance are essential. Unit *A* is fractional hp, goes right in pipe. *B* has axial air-gap motor, is built in 10-hp and smaller sizes. *C* is chemical unit, *D* one for nuclear-energy service.

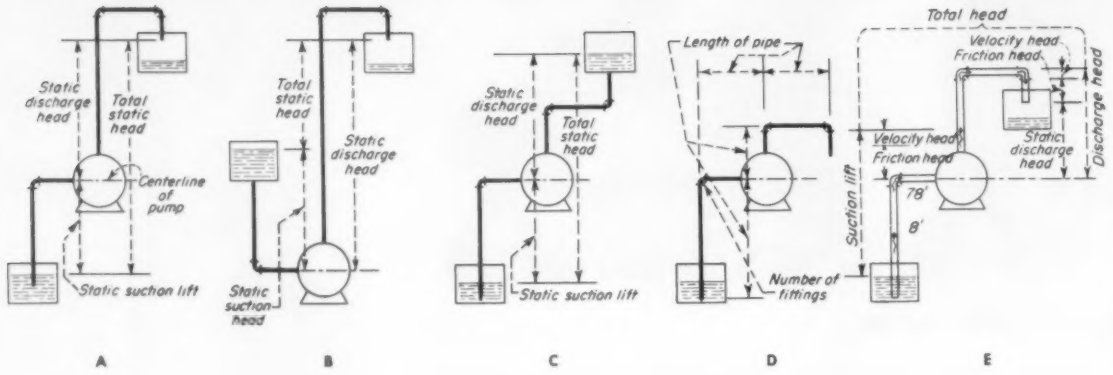


High-pressure services

Where quick starts, compact installation and steam drive are desirable, as in certain boiler-feed applications, petroleum refining, etc, the high-pressure turbine-driven type shown above has many uses. It consists of a single-stage impeller near one end of the shaft; at the other end is a velocity-staged turbine wheel. Single shaft produces a compact unit easy to install and operate.



Typical piping hookups for pumps serving industrial loads



Pump selection . . . 5 steps to

Selecting a pump is much like buying a hat—you have three major decisions to make. These are *size, type* and *best buy*. But of course choosing a pump can be a far more complex problem, especially where unusual or difficult liquid conditions are met. Steps outlined below have proven suitable for typical general-purpose, process and similar applications. Selection of other types — boiler-feed, condensate-return, hydraulic-system, etc. — usually involves analysis of factors not directly related to the pump itself. For example, you might have to compute several plant heat balances before you can make a firm decision on boiler-feed pump type, capacity, drive, etc., best for the existing conditions. Some of these factors were discussed earlier; others are too complex for coverage here.

1 Sketch layout (see diagrams above)

Trying to pick a pump without a sketch of the system layout is like a miner trying to work without his lamp. You're in the dark from start to finish. Base sketch on actual job, as planned. Show all piping, fittings, valves, equipment, etc. Mark length of pipe runs of sketch. Be sure to include all vertical lifts. Where piping is complex, an isometric sketch is often extremely helpful.

2 Determine capacity (see Table I)

Job conditions fix capacity required. For example, maximum steam flow from the exhaust of a turbine, along with steam conditions, determines the minimum amount of cooling water at a given temperature. Seasonal changes, safety factor desired, etc., influence actual capacity chosen. Where demand is unknown and must be estimated, Table I is a big help in indicating typical ranges to be expected. It does *not*, however, give exact values because there can be wide variations from one installation to another. Except for small pumps and those for metering and proportioning, capacity is expressed in gallons per minute (gpm).

3 Figure total head (see Tables II, III)

Diagrams above show various heads in typical pumping systems. Definitions, *facing page*, will help you understand the meanings of various terms. If a pump handles 500 gpm of water through 86 ft of 6-in. suction pipe, diagram above right, and there is one medium-radius elbow having a resistance equal to 14 ft of straight pipe, total equivalent length of suction pipe is 86 + 14 = 100 ft. Friction loss from Table II is 1.7 ft of water per 100 ft of pipe. Velocity head is almost 0.5 ft and static suction lift is 8 ft. Hence, suction lift is 8 + 1.7 + 0.5 = 10.2 ft. Discharge head is found in a similar way, using discharge pipe size, length of runs and fittings in the line. Total head is the sum of suction lift and discharge head. Where we have a static suction head, as in the second hookup from the left, we subtract suction head from discharge head to obtain the total head. Always have pump manufacturer check your head calculations. Then you'll be certain the pump is suitable.

4 Study liquid conditions (see p 85)

Up to this point we've determined but two requirements our pump must meet — head and capacity. Now we come to characteristics of the liquid and their effect on pump selection. Liquid heavier than water (specific gravity greater than 1) takes more horsepower to be moved from one point to another; lighter liquids require less power. Liquid temperature and vapor pressure fix the net positive suction head needed for satisfactory operation. Unless you are thoroughly experienced with this phase of pump selection, it is best to have the manufacturer check suction conditions. Viscosity of liquid affects horsepower, head and

DEFINITIONS

STATIC SUCTION LIFT is vertical distance, ft, from supply level to pump centerline; pump above supply.

STATIC SUCTION HEAD: same as static suction lift, but pump is below supply level.

STATIC DISCHARGE HEAD is vertical distance, ft, from pump centerline to point of free delivery.

TOTAL STATIC HEAD is vertical distance, ft, from supply level to discharge level.

FRICTION HEAD is pressure, in ft of liquid, needed to overcome resistance of pipe, fittings.

SUCTION LIFT is static suction head plus suction friction head and velocity head.

SUCTION HEAD is static suction head minus suction friction head and velocity head.

DISCHARGE HEAD is static discharge head plus discharge friction head and velocity head.

TOTAL HEAD is sum of suction lift and discharge head. Where there is suction head, total head is difference between discharge and suction heads.

NOTE: Some engineers use *dynamic suction lift, dynamic discharge head* and *total dynamic head* instead of terms above. While the word *dynamic* helps express idea of motion, ie, head when liquid is flowing, the simpler terms are favored.

I: TYPICAL WATER REQUIREMENTS

Usual buildings*			Cities and towns	
Fixture	Cold, gpm	Hot, gpm	Population	Total**, gpm
Water-closet flush valve	45	0	1000	800
Water-closet flush tank	10	0	2000	1200
Urinals, flush valve	30	0	3000	1500
Urinals, flush tank	10	0	4000	1700
Lavatories	3	3	5000	2000
Shower, 4-in. head	3	3	6000	2200
Shower, 6-in. and larger	6	6	8000	2700
Needle bath	30	30	9000	2900
Shampoo spray	1	1	10,000	3100
Baths, tub	5	5	20,000	5100
Kitchen sink	4	4	40,000	8700
Pantry sink, ordinary	2	2	50,000	11,000
Pantry sink, large bibb	6	6	60,000	13,000
Slop sinks	6	6	100,000	19,000
Wash trays	3	3	150,000	28,000
Laundry tray	6	6	180,000	33,000
Garden-hose bibb	10	0	200,000	37,000

*Approximate maximum flow from fixtures: to obtain maximum probable flow, multiply maximum possible flow by a usage factor based on previous experience.

**Total includes water for domestic supply and fire protection. Where city or town is predominantly industrial, a greater flow will probably be required.

better results

capacity, as well as class of pump chosen. Here, again, your best bet is the manufacturer. Liquid pH influences pump materials, p 85, while solids affect mechanical construction.

5 Choose class and type (see pp 76-77)

Studying the layout, like trying on a hat, tells us what *size* (capacity and head) pump we need. This furnishes our first lead as to what class of pump is suitable. For example, where high-head small-capacity service is required, table p 77, shows that a reciprocating pump would probably be suitable. Reviewing the liquid characteristics furnishes another clue to class because exceptionally severe conditions may rule out one or another right at the start. Sound economics dictates choosing the pump that provides the lowest cost per gallon pumped over the useful life of the unit.

Operating factors deserving recognition when deciding on class include type of service (continuous or intermittent), running-speed preferences (high-speed pumps often cost less), future load expected and its effect on pump head, possibility of parallel or series hookup, and many others peculiar to a given job. These factors deserve as much study as head and capacity; they're just as important.

Once you know class and type you're ready to check these in a rating table, p 104, or a rating chart as on p 87. As you can see, the table lists pump capacity, head, horsepower, etc. Where required capacity and head, or both, falls between two tabulated values, it is usual practice to choose a pump to meet the next larger condition where this is not too far from the existing job conditions. Otherwise, another make or type of pump may have to be used.

One important fact to keep in mind is that many large pumps are custom-built for a given plant or application. Under these conditions the pump manufacturer performs most of the steps listed above, basing his design on information supplied by the engineer on the job.

II: PIPE FRICTION LOSS FOR WATER

(Wrought-iron or steel Schedule 40 pipe in good condition)

Dia, in.	Flow, gpm	Velocity, ft per sec	Velocity head, ft of water	Friction loss, ft of water per 100 ft pipe
2	50	4.78	0.355	4.67
2	100	9.56	1.42	17.4
2	150	14.3	3.20	38.0
2	200	19.1	5.68	66.3
2	300	28.7	12.8	146
4	200	5.04	0.395	2.27
4	300	7.56	0.888	4.89
4	500	12.6	2.47	13.0
4	1000	25.2	9.87	50.2
4	2000	50.4	39.5	196
6	200	2.22	0.0767	0.299
6	500	5.55	0.479	1.66
6	1000	11.1	1.92	6.17
6	2000	22.2	7.67	23.8
6	4000	44.4	30.7	93.1
8	500	3.21	0.160	0.424
8	1000	6.41	0.639	1.56
8	2000	12.8	2.56	5.86
8	4000	25.7	10.2	22.6
8	8000	51.3	40.9	88.6
10	1000	3.93	0.240	0.497
10	3000	11.8	2.16	4.00
10	5000	19.6	5.99	10.8
10	7500	29.5	13.5	24.0
10	10,000	39.3	24.0	42.2
12	2000	5.73	0.511	0.776
12	5000	14.3	3.19	4.47
12	10,000	28.7	12.8	17.4
12	15,000	43.0	28.7	38.4
12	20,000	57.3	51.1	68.1

III: RESISTANCE OF FITTINGS AND VALVES

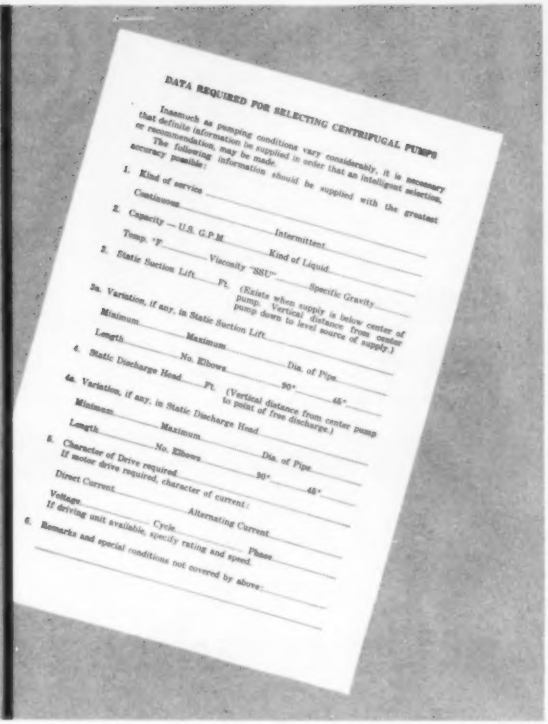
(Length of straight pipe, ft, giving equivalent resistance)

Pipe size, in.	Std ell	Med-rad ell	Long-rad ell	45-deg ell	Tee	Gate valve, open	Globe valve, open	Swing check, open
1	2.7	2.3	1.7	1.3	5.8	0.6	27	6.7
2	5.5	4.6	3.5	2.5	11.0	1.2	57	13
3	8.1	6.8	5.1	3.8	17.0	1.7	85	20
4	11.0	9.1	7.0	5.0	22	2.3	110	27
5	14.0	12.0	8.9	6.1	27	2.9	140	33
6	16.0	14.0	11.0	7.7	33	3.5	160	40
8	21	18.0	14.0	10.0	43	4.5	220	53
10	26	22	17.0	13.0	56	5.7	290	67
12	32	26	20.0	15.0	66	6.7	340	80
14	36	31	23	17.0	76	8.0	390	93
16	42	35	27	19.0	87	9.0	430	107
18	46	40	30	21	100	10.2	500	120
20	52	43	34	23	110	12.0	560	134
24	63	53	40	28	140	14.0	680	160
36	94	79	60	43	200	20.0	1000	240

Typical centrifugal-pump rating table

Size	Gpm	Total head, ft 10	15	20	25	30
2C	100			1000-.8	1060-1.0	1150-1.2
	150			1070-1.2	1150-1.5	1240-1.7
	200				1290-2.1	1360-2.4
3CS	150	750-.53	850-.78	950-1	1030-1.2	1100-1.5
	200		950-1.1	1010-1.4	1100-1.7	1170-2
	250			1170-1.9	1190-2.3	1260-2.6
	300					1400-3.5
3CL	200	690-.63	800-.95	910-1.3	1010-1.6	1110-2.05
	300	870-1.2	950-1.6	1000-1.9	1100-2.4	1170-2.8
	400			1200-3.1	1230-3.7	1290-4.1
	500					1490-5.8
4C	400	750-1.3	850-1.8	940-2.4	1040-3	1120-3.7
	600			1080-4	1170-4.6	1210-5.5
	800					1400-8.4
1¼D	25		617-.21	707-.03	778-.40	845-.51
	50		680-.37	760-.49	865-.63	900-.76
	75			856-.78	916-.94	980-1.1
	100					
	125					
	150					
2DL	150		820-.93	850-1.1	930-1.35	990-1.6
	200			970-1.8	1040-2.1	1080-2.3
	250					
	300					

Example: 1080-4 indicates pump speed is 1080 rpm; actual input required to operate pump is 4 hp.



DATA REQUIRED FOR SELECTING CENTRIFUGAL PUMPS

Inasmuch as pumping conditions vary considerably, it is necessary that definite information be supplied in order that an intelligent selection, or recommendation, may be made.
The following information should be supplied with the greatest accuracy possible:

1. Kind of service
   Continuous _____ Intermittent _____
2. Capacity — U.S. G.P.M. _____ Kind of Liquid _____
   Temp. °F. _____ Viscosity "SSU" _____ Specific Gravity _____
3. Static Suction Lift _____ Ft. (Exists when supply is below center of pump. Vertical distance from center of pump down to level source of supply.)
   3a. Variation, if any, in Static Suction Lift.
   Minimum _____ Maximum _____
   Length _____ Dia. of Pipe _____
   No. Elbows _____ 90° _____ 45° _____
4. Static Discharge Head _____ Ft. (Vertical distance from center pump to point of free discharge.)
   4a. Variation, if any, in Static Discharge Head
   Minimum _____ Maximum _____
   Length _____ Dia. of Pipe _____
   No. Elbows _____ 90° _____ 45° _____
5. Character of Drive required _____
   If motor drive required, character of current:
   Direct Current _____ Alternating Current _____
   Voltage _____ Cycle _____ Phase _____
   If driving unit available, specify rating and speed.
6. Remarks and special conditions not covered by above:

Other considerations in choosing pumps

Our previous two pages outline usual steps in choosing a pump for typical industrial services. There are cases, however, where selection is better made by the pump builder.

Estimating data sheets, *above right,* are available from manufacturers to aid you in making a complete statement of conditions a new pump must meet. When sending such an estimate to a manufacturer it is wise to include a clear free-hand sketch of the installation.

While the sheet shown is for a centrifugal pump, forms for reciprocating and rotary estimates resemble this closely. Having the manufacturer select your pump insures getting the right unit, *provided* you supply the information he needs.

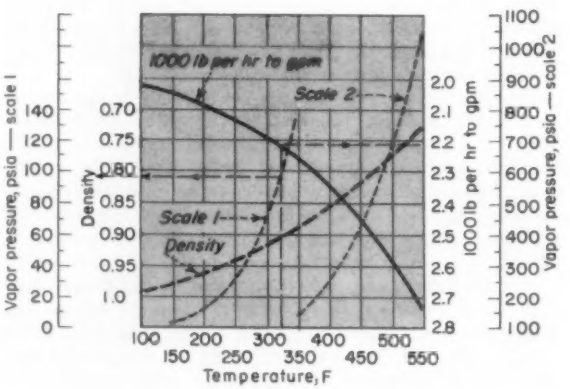
Net positive suction head is often listed on estimate sheets and must be entered to give a complete picture of pumping conditions. This term gives pressure available or required to force a given flow, gpm, into the impeller, cylinder or casing of a pump. For uniformity, npsh is stated as feet of liquid equivalent to required pressure in psi over and above vapor pressure of liquid at pumping temperature.

Every pump has its individual required npsh characteristics which the manufacturer can plot on a performance curve. Npsh at any point on the curve is head in feet of liquid pumped equivalent to pressure in psi required to force liquid into the pump. Values shown by pump manufacturer are based on tests and are regularly corrected to the centerline of the pump.

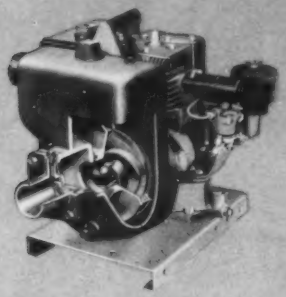
As engineer in charge of plant services you must locate the pump and design the suction piping so available npsh is equal to or greater than npsh required by pump. Curves, *right,* give vapor pressure of water at different temperatures. They also give conversion factors for changing flow from lb per hour to gpm. Both are useful in planning.

Pipe sizes for lines where flow demand is likely to change or resistance may increase over a period of years require careful study. If sized only on basis of today's demands or resistance, we may find that what was once an economical installation becomes a money-waster.

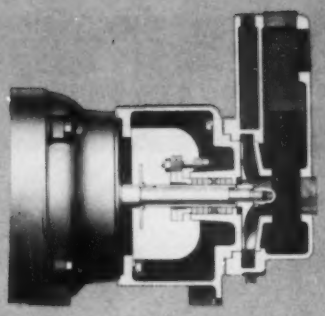
Complete Analysis. Though not all jobs warrant it, a piping system can be completely analyzed for present and future operations by using pump characteristic and system-head curves like those on p 86. But instead of plotting one system-head curve, a series, one for each operating condition, is plotted. Study of these will show just what we may expect from a given pump today, tomorrow, and five or more years from now. This is a job for the engineer in the plant and it deserves more attention than it usually receives.



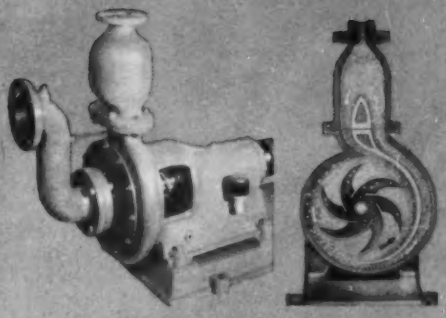
SIX SELF-PRIMING PUMPS



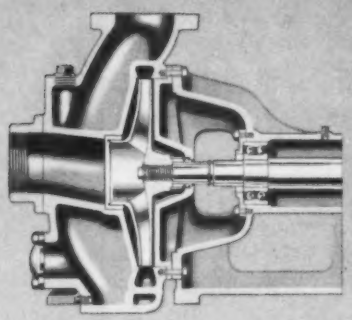
DIFFUSER priming method here does not return liquid to suction side of the pump



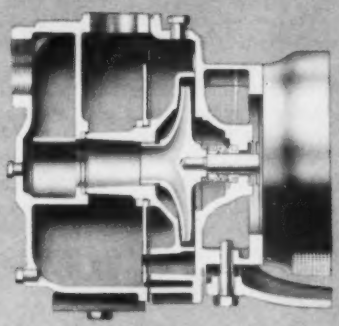
DOUBLE VOLUTE recirculates liquid-vapor mixture during prime, separates vapor



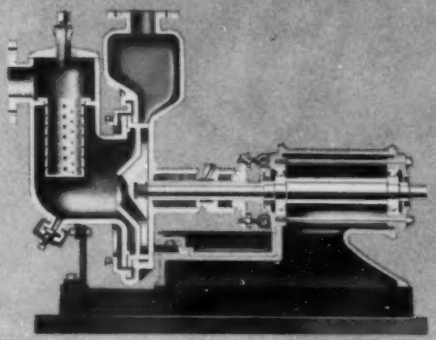
AIR SEPARATOR and two discharge ports in pump give priming action in this unit



PRIMING CHAMBER in this unit surrounds straight-in suction; no valves are used

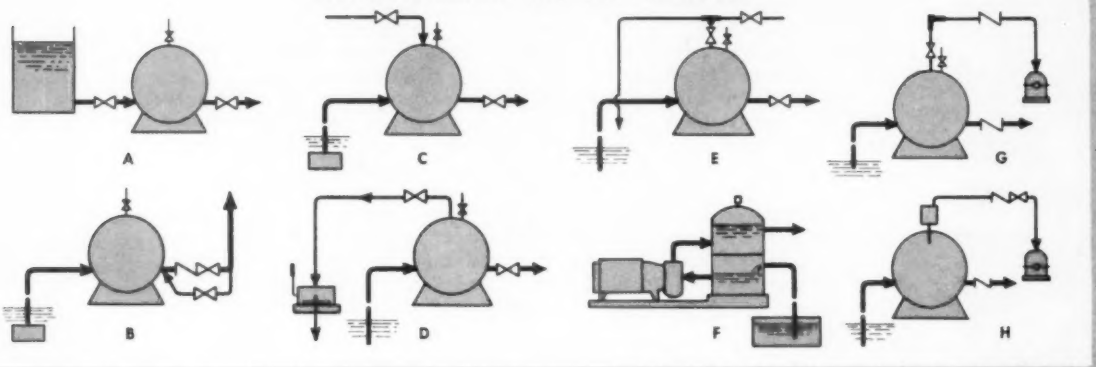


LIQUID flows into lower volute and out upper volute during priming in this unit



SLOTS in impeller vanes permit air to be entrained by priming liquid in this pump

EIGHT AUXILIARY PRIMING METHODS



Priming pumps

Positive-displacement pumps — reciprocating and rotary — are self-priming for total suction lifts to about 28 ft. when in good condition. But with long suction lines, high lifts or other abnormal conditions, they must be primed.

Centrifugal pumps are not self-priming; on a suction lift they must be primed. Either special self-priming units may be used or auxiliary priming equipment may be installed.

Illustrations at top of this page show six modern self-priming units. Designs vary from one maker to another, but a liquid reservoir of some type on the discharge is common. It holds priming liquid and serves as an air separator. Other designs have a liquid reservoir on both suction and discharge, liquid being circulated from discharge to suction on prime. Automatic valves or hydraulic action stop circulation after pump primes. Some pumps circulate liquid continuously.

Auxiliary equipment for pump priming includes ejectors, vacuum pumps, etc., used in hookups like those sketched.

With a flooded suction, *A*, open casing air-vent petcocks and then slowly open suction gate valve. Incoming liquid pushes air from casing. Bypass around discharge check valve, *B*, permits using liquid in discharge line. Foot valve, *C*, holds water in suction line, is augmented by auxiliary supply. Separate pump, *D*, draws air from casing for priming. Or an ejector, *E*, does same job. Priming tank, *F*, holds supply of liquid large enough to establish flow through pump on starting. Vacuum pumps, *G* and *H*, are manually and automatically controlled to prime the main pump.

Pumps on the job

Installation

Your best bet on correct installation procedures is the instruction manual supplied with your pump by its manufacturer. Remember, he spends considerable time, money and skill in assembling these manuals with the hope you will use them when the pump reaches your plant. Use the manual even where a contractor is responsible for installing the pump. Don't assume grouting, alignment and bolting-down are so simple that they needn't be checked.

Today's pumps, as a class of machinery, are among the most carefully built units available. So you are starting with a good product that will give years of dependable service without a hitch. Use *Standards of Hydraulic Institute* for many general helpful hints on pump location, layout and run of suction piping, type of fittings, etc. In many instances these will duplicate the manufacturer's manual but it is well worthwhile to become familiar with the *Standards* because they contain much other valuable information. Past articles in POWER will also help you strengthen your background on pump installation. See the following issues for sure-fire aids: Feb 1945, Nov 1948, Jan 1950, June 1952, Feb, April 1953.

Operation

Major items of concern in pump operation include satisfactory prime (p 105), right direction of rotation, correct adjustment of packing, if used, a good supply of the recommended lubricant, adjustment of sealing-liquid flow, and proper opening of valves in suction and discharge lines. Generally speaking, correctly installed pumps run without troubles for years if checked regularly.

Once again, your surest and shortest road to good operation is your instruction manual because it is aimed specifically at your pump and, for custom-built units, at your particular installation. There is no reliable substitute for the years of experience pump manufacturers have had with jobs similar to or exactly like yours. So use your manual carefully and see that your operators know the whys and wherefores of the units under their care. Correct starting, running and stopping procedures help spin off troublefree years of dependable service. Of course, you must be alert at all times for conditions inside and outside the pump that may affect operation. See the following POWER articles for good tips: April, July and Sept 1950, Jan, April, May and June 1952, June and Nov 1953.

Maintenance

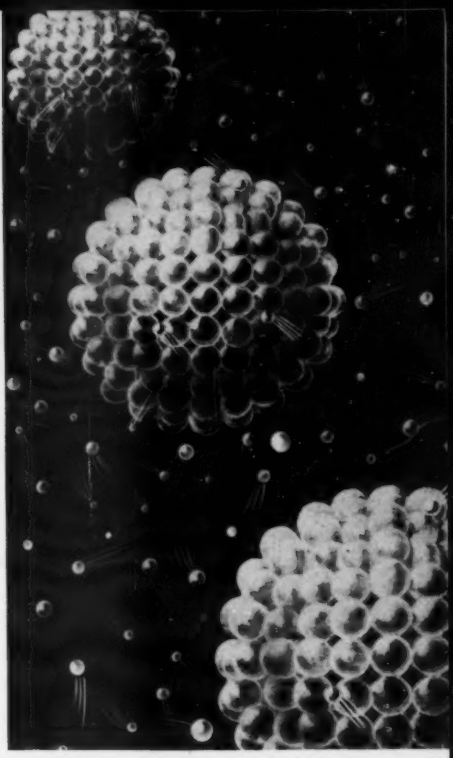
Checks with manufacturers and pump operators show a growing tendency to bypass the annual tear-down for inspection of interior parts. Opinion on this subject is divided, however, and you'll have to evaluate the various arguments in terms of your job and pumping conditions before reaching a final decision on annual tear-down. As an example of what is possible, some boiler-feed pumps have been on the line for over 100,000 hours without being opened for inspection or overhaul. And these units are still ticking off the hours, day after day.

Manual supplied by manufacturer should be your maintenance bible because it contains numerous tips on problems that may arise. It is especially important for large units where disassembly and assembly may be major undertakings requiring a high degree of mechanical skill and experience. Of course, you should make full use of advice the manufacturer can offer on specific maintenance problems. And you are certain to gain by making periodic checks of pump performance to see if it departs markedly from the guarantee. See the following POWER articles: Jan, April, May and June 1952, June and Nov 1953.

POWER wishes to thank pump manufacturers and engineers throughout the country not only for supplying illustrations but for much helpful advice and criticism in the preparation of this handbook.

NUCLEAR-ENERGY STUDY COURSE: NUMBER 4

Changing mass to energy



Changing atoms from one element to form other elements was an exciting event in the development of science—but the outstanding achievement was realizing that we could change matter into useful energy for power purposes

By HENRY C SCHWENK, *Henry Pratt Company*
and ROBERT H SHANNON, *United Engineers and Constructors, Inc*

► AT THE TURN of the century, Einstein theorized that mass and energy were interchangeable—that they were two aspects of the same thing. This came about when his calculations proved that the mass of a moving body increased as its speed increased, which meant that the mass of a body was a measure of its energy content. This exciting theorem helped lay the groundwork for the release of nuclear energy some 40 years later.

Einstein showed that the relationship between mass and energy was given by the equation:

$E = MC^2$

where

E = Energy in ergs
M = Mass in grams
C = Speed of light, cm/sec (3×10^{10}) $(= 186{,}000$ miles per second).

This equation, fundamental to the whole subject of atomic energy, shows there is an exact equivalence between mass and energy. With the extremely large size of the conversion factor it points startlingly toward the tremendous energy possibilities if a finite quantity of mass can be "converted."

The familiar burning of fuel in oxygen also involves changing mass to energy. But the change in mass is so small that this equivalence was never observed in ordinary chemical reactions. For instance, when coal with a heating value of 13,000 Btu per pound burns completely, only 1/3 of a billionth pound of mass converts to produce the 13,000 Btu, certainly an amount too small to be detected by any measuring method.

On the other hand, nuclear reactions involve much larger changes in mass, relatively speaking, with a consequent much greater energy release. As an example, let us calculate the energy equivalent of 1 amu (atomic-mass unit), roughly equal to the mass of one neutron or one proton (see Table I, Part 2, August 1954 POWER.) One amu equals 1.66×10^{-24} gram, an extremely small value. Substituting this in the equation we get:

$$E = (1.66 \times 10^{-24})\ (3 \times 10^{10})^2$$
$$= 0.00149 \text{ erg}$$

That is, 1 amu of mass is equivalent to 0.00149 ergs of energy. But in nucleonics we usually measure energy in electron volts or million electron volts (mev). Since 1 mev $= 1.6 \times 10^{-6}$ ergs, then:

$$1 \text{ amu} = (1.49 \times 10^{-3}) / 1.60 \times 10^{-6}$$
$$= 931 \text{ mev}$$

These are unfamiliar units to an engineer, so let's see how they look in more common terms. Since there are 453.6 grams to a pound and 3.6×10^{13} ergs in a kwhr, this figures out that 1 pound of mass equals 11.3 billion kwhr, which also equals 38.7 trillion Btu.

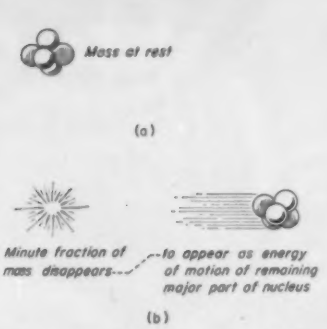
What does this mean? In the case of our 13,000-Btu-per-pound coal, if we can find a way to convert the whole pound mass into energy, we can get 3.4 billion times more energy than by chemical burning. No way has been found to convert *all* of a given bulk of matter to energy, however, but in the normal fissioning of uranium about 1/1000th of the mass disappears. So when we fission 1 pound of U-235, we get about 3,000,000 times more energy than by burning one pound of 13,000-Btu coal.

Nuclear stability. Now that we understand more of the relationship between matter and energy, let us take a close look at conditions in the nucleus of an atom. Since protons carry plus charges of electricity and plus charges repel each other, we might easily jump to the conclusion that it would be impossible for a nucleus to contain more than one proton. But since so many nuclei are stable, there must be forces of attraction within them that act over the minute distances within the nucleus.

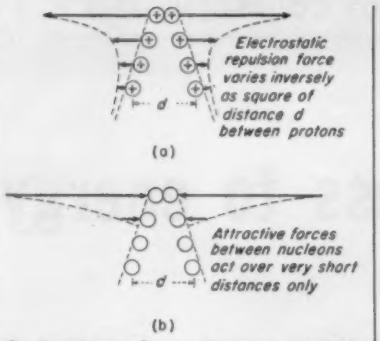
On the other hand, the electrostatic forces of attraction and repulsion and the gravitational forces act over relatively long distances, Fig. 2. These short-range forces within the nucleus may exist between proton-neutron, proton-proton and neutron-neutron.

The ratio of the number of neutrons to protons in nuclides* determines the relative stability of atoms. Over definite ranges of neutron-proton ratios the short-range forces overcome the electrostatic repulsion forces to keep the nuclide stable. For the lighter nuclides this ratio is near unity. As the atomic number increases, however, the ratio rises as more neutrons are needed to overcome the greater electrostatic repulsion of the protons. *Turn page*

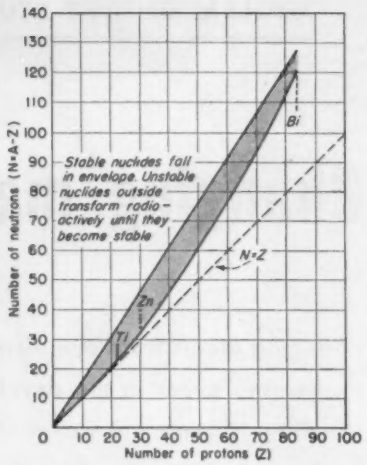
*Nuclide: a species of atom characterized by the number of neutrons and protons it contains. Sometimes used in place of the word *isotope*.



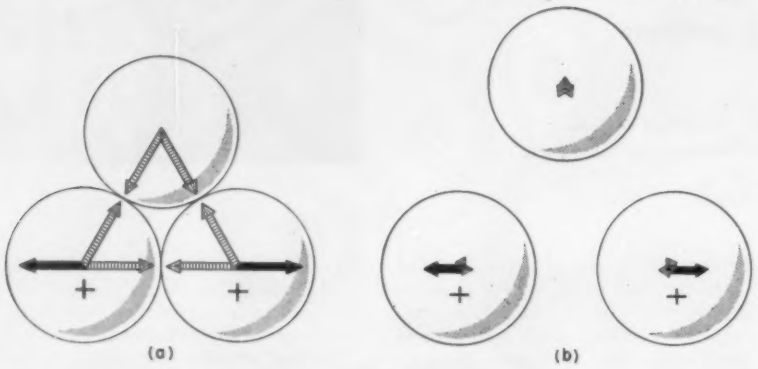
1 If we can find the secret of how to do it, mass will change to energy. Destroying 1 lb of mass creates 38.7 trillion Btu equaling 11.3 million kwhr


Electrostatic repulsion force varies inversely as square of distance d between protons
d
(a)
Attractive forces between nucleons act over very short distances only
d
(b)

2 Repulsion forces between protons act over longer distances than the attractive forces between all nucleons. Latter forces hold atomic nuclei intact



4 Larger nuclides have more neutrons than protons so attractive forces can overbalance the proton repulsion forces



3 Helium-3 nucleus shows that attractive forces between nucleons overcome proton repulsions in (*a*). But if we pull nucleus apart as in (*b*), the repulsion forces, which dominate at these greater distances, help complete the separation of particles

Cohesive forces hold protons and neutrons together as a nucleus

Near the end of the periodic table the neutrons per nuclide rise to nearly 150 and the protons to around 90. We find that the excess of neutrons gives a neutron-proton ratio well above unity. As a result, a certain amount of instability occurs in the elements above bismuth, $_{83}Bi^{209}$, which has a ratio of 1.5. The nuclides above this element are *radioactive*, see Part 3, September 1954 POWER. They release energy in the form of gamma rays or nuclear particles in attempting to reach stability by bringing their neutron-proton ratio back within the proper range.

Fig. 4 shows a neutron-proton plot of the stable nuclides. They tend to fall into a narrow band on the plot, which defines the region of nuclear stability. The ratio is near unity for the lighter nuclei and increases steadily for the heavier nuclei as more neutrons are added. Any nuclides in the region outside the band are unstable and will emit radiations to reach a stable condition within the band.

Mass defect. If we could gather atomic particles individually and build them into an atom, we would find that the assembled atom weighed less than the total weight of the original individual neutrons, protons and electrons. Fig. 5 shows the results for a helium atom built up of 2 neutrons, 2 protons and 2 electrons. Weights of these particles were given in Part 2, August 1954, POWER. The weight of the $_2He^4$ isotope is the actual weight as found by experiment.

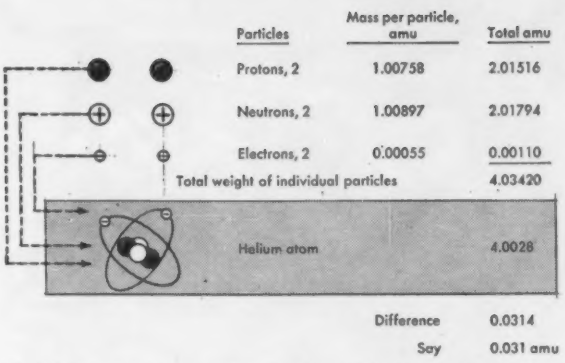
The difference between summation of individual particle weights and actual weight of the atom is called the *mass defect*. It represents the amount of mass of the original particles that would be converted to energy during the original formation of the atom. Looking at Fig. 6, this implies that as the particles are brought together quickly the mass equal to the mass defect would suddenly disappear by changing into energy. This energy might appear in the form of kinetic energy imparted to the atom being created.

By the same token, to break up an atom into its individual particles the energy equivalent of the mass defect would have to be supplied from some source. This *mass defect* is, therefore, evidence of the existence of an *energy of binding* in nuclei. The mass defect of the helium isotope in Fig. 5 is 0.031 amu, only ¾% of the isotopic weight. But we have just learned that 1 amu = 931 mev according to the Einstein equation. So the binding energy for $_2He^4$ is:

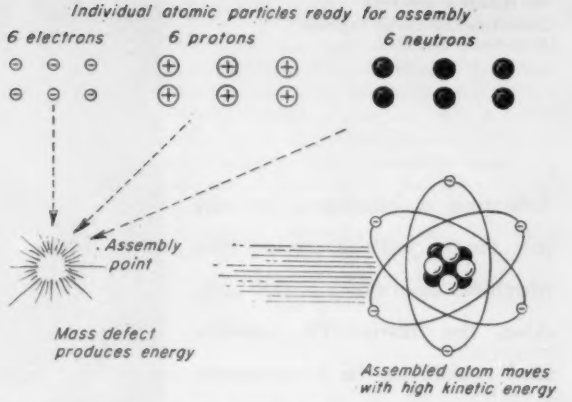
$$E = 931 \times 0.031 = 28.8 \text{ mev}$$

Since there are four nucleons in this isotope (two protons and two neutrons) the energy is $28.8/4 = 7.2$ mev per nucleon. In more familiar terms this means that if we could break up all the nuclei in one pound of helium atoms, we would have to supply about 88,000,000 kwhr of energy. Or in the reverse process, assembling one pound of helium atoms from the basic particles would release a total energy of 88,000,000 kwhr.

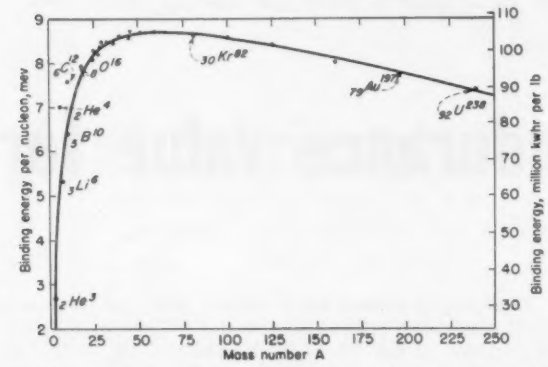
Binding energy. So we have seen that a small amount of mass is equivalent to a tremendous amount of energy and that rearranging atomic nuclei, with a consequent reduction in their total mass, releases this energy. One way this can



5 When we add up the mass of individual particles that go into a helium atom, we find they weigh more than the atom



6 At instant an atom is made up from its basic particles a small amount of mass changes to energy, kicking atom along



7 Moving up on this curve frees energy, so we generate atomic energy by combining light atoms or splitting heavy ones

Table I: What nuclear measuring units mean

ENERGY

1 erg = work done when a force of 1 dyne acts through a distance of 1 cm

1 dyne = force acting on a mass of 1 gram giving it an acceleration of 1 cm per sec per sec

1 ev (electron volt) = energy acquired by any charged particle carrying a unit electrical charge when it passes without resistance through a potential difference of 1 volt = 1.60×10^{-12} erg

1 kev (kiloelectron volt) = 1,000 ev

1 mev (million electron volts) = 1,000,000 ev
= 1.52×10^{-16} Btu
= 4.45×10^{-20} kwhr

1 bev (billion electron volts) = 1,000,000,000 ev

MASS

1 amu (atomic mass unit) = arbitrary unit based on mass of oxygen isotope O-16 being chosen as 16.0000
= 1.66×10^{-24} gram
= 3.66×10^{-27} lb

be done is by combining protons and neutrons, or the light nuclides (fusion). There is, however, another way of developing energy from matter and that is by the process of breaking up heavy nuclides into ones of intermediate size (fission).

The *binding energy* of the nuclides is a direct measure of nuclear stability and thus the key to this energy release. Let us first look at the binding energies for a range of nuclides. These can be calculated in mev by:

Binding energy
$$= 931\ [Z m_p (A-Z) m_n - M]$$
where

m_p = proton mass = 1.00758 amu
m_n = neutron mass = 1.00897 amu
M = actual mass of assembled nuclide, amu
Z = atomic number = no. of protons
A = mass number = no. of nucleons
$A-Z$ = no. of neutrons

The binding energy of the electrons associated with the nucleus is usually neglected because it is a very small fraction of the total atomic binding energy.

We can find the average binding energy *per nucleon* by dividing the total binding energy by the mass number as we just did for the isotope He-4, above. Plotting the average binding energy per nucleon for the nuclides whose isotopic weights we know gives us the smooth trend curve in Fig. 7. A few of the light nuclides do not lie directly on the curve.

Looking at the range of the trend curve we see that the binding energy per nucleon rises rapidly to a maximum of 8.7 mev at about $A = 60$ (nickel) and then drops gradually to about 7.4 mev for uranium. The nuclides in the middle of the periodic table, $A = 40$ to 100, are most strongly bound. The flat shape of the curve in this range shows that the *total* binding energy is roughly proportional to the number of nucleons in the atom. In the use of this curve remember that the binding energy is the energy *released* in the formation of the nuclide in question.

The lower binding energy for the heavy nuclides gives us the clue to the energy released during fission. As the curve falls off for the heavier nuclei the binding energy for each successive neutron or proton is less and less. As we said before, the electrostatic repulsion has a stronger effect in the nuclides of higher mass number, contributing to their lower stability. This means they can split more easily under the proper conditions. When we fission a uranium nucleus, the fission fragments consist of nuclei of two elements somewhere in the middle range of the binding energy curve. But these elements have a higher binding energy per nucleon. That is, the nuclei are more tightly bound in the two fission fragments than they were in the original single nucleus.

From the mass defect standpoint, this means that when we add up the mass of all the pieces after fission (the two fragments, the ejected neutrons and radiation particles) it is less than the mass of the original uranium atom and the neutron that caused fission. The missing mass changed to energy.

Putting it in other words, the result of fission is an over-all increase in the

(*Continued on page* 214)

By **ALLEN F BREWER**
Consulting Lubrication Engineer
Avon-by-the-Sea, N. J.

Selecting a lubricant for any job starts with knowing the machine operating conditions. Also, the lubricant's stability and resistance to breakdown should be considered since they are key factors in . . .

MECHANICAL TROUBLE, being spotted here with a stethoscope, is often avoided by understanding and applying the factors affecting a lubricant's endurance value

Pinning down the endurance value for

KNOWING IN ADVANCE something about the endurance value of a petroleum oil or grease is of significant interest to the lubrication engineer and the engineer operating a plant. If machines are designed for effective lubrication, and proper lube-application equipment is available, the remaining major problem is selecting the most suitable lubricant. This selection hinges largely on the operating conditions: *temperature, speed, load, possible contamination.*

It is conventional practice today to select lubricants to meet these operating conditions by drawing on certain physical tests that denote the product's general nature. Example: Lubricating oils are designated according to their viscosity, flash and fire points, pour-point temperature, carbon-residue content, acidity (by neutralization number), color and, possibly, gravity. In turn, petroleum greases are designated by their dropping point (temperature), consistency and NLGI number, soap content (nature and amount), viscosity of oil content.

How valuable? These tests are of relative value depending on where the lubricant will be applied. Take an oil for a steam turbine or hydraulic system. Here neutralization number and stability in terms of resistance to rust and oxidation are the most important factors, assuming viscosity is in line with the machinery builder's recommendations. However, a refrigeration-grade oil must have a low pour-test value and there should be a minimum tendency for wax congealment at the prospective minimum temperatures. Viscosity is generally decided upon in accord with the machine builder's recommendations. Dropping point and consistency of grease must be considered for prepacked or factory-sealed ball bearings.

The above factors help determine the suitability of a lubricant for a given job. Once the suitability is pinned down, the endurance value, indicated by an oil's stability and resistance to breakdown, becomes the most important factor in mating a lubricant to a particular machine.

Predicting endurance value requires tests that go beyond the conventional laboratory procedures: determining wetting ability of the lubricant, its film-forming ability, its behavior in presence of water, its tendency to form sludge or saponifiable byproducts. Such tests pin down values of surface tension, interfacial tension, saponification, emulsification, adhesion. Their individual importance to the lubrication engineer depends on the service conditions.

Wetting ability of the lubricating oil is a most important characteristic. Effective lubrication needs a lube film that actually wets the moving surfaces. Wetting ability, a function of adhesion, can be determined qualitatively by coating a steel strip with oil. A satisfactory oil, at least from a wetting-ability angle, will retain the oil film when dipped in water; the water will drain off when steel strip is removed. If wetting ability is poor, the water will displace the oil film. Warm water speeds up oil displacement.

Surface tension of an oil film varies with viscosity and temperature. Since surface tension is an indication of relative film strength, a higher-viscosity oil, without film-assisting additives and with comparable degree of refinement, generally possesses greater film strength under like temperature conditions. Surface tension decreases as temperature increases.

Relation of surface tension to emulsion-forming tendency is another interesting feature. An oil having a low surface tension forms smaller droplets than one with the same viscosity but with a higher surface tension. This is a desirable feature where rapid emulsification is essential, as with steam cylinder oils or compounded compressor oils.

Look upon surface tension as cohesive action of particles composing the liquid. These cohesive particles act in all directions below the surface. A particle within the liquid is attracted equally on all sides, but a particle in the surface layer is attracted inward by liquid particles within the sphere of influence. A corresponding attraction by the few

These 5 factors help predict lubricant's endurance value*

1 **SURFACE TENSION** is the contracting surface force of a liquid by which it tends to assume a spherical form, presenting the least possible surface

2 **INTERFACIAL TENSION** may be defined as the energy per unit area present at the boundary of two immiscible liquids

3 **SAPONIFICATION** is a process in which a fat (or other compound of an acid with an alcohol) reacts with an alkali to form a soap-and-glycerin or other alcohol

4 **EMULSIFICATION** is a mechanical mixture of two insoluble liquids, as oil and water

5 **ADHESION** involves the interfacial forces that react at the dividing surfaces between liquids and solids. In other words, the force that draws a liquid to a solid

plant lubricants

particles in the vapor space above the liquid is negligible in comparison. As a result, at the surface of every liquid there is a force, surface tension, acting inward, giving the effect of an elastic skin covering.

A torsional balance is generally used to study both interfacial and surface tension. Force, required to pull a platinum-wire ring through the interface of an oil layer floating on water in a suitable container, is a measurement of the interfacial tension. Force required to pull the ring free from the oil is a measure of the surface tension.

The real significance of surface tension, to those concerned with plant operation, lies in its relationship to wetting ability and film strength.

Interfacial tension is related to oxidation since compounds formed as a result of oxidation tend to reduce its value. As these compounds usually have an emulsifying attraction for water, a lower interfacial tension may indicate the presence of nonlubricating materials. However, this indication is not infallible since some of the additives, currently used to inhibit rust and oxidation in turbine or hydraulic oils, also have a tendency to reduce an oil's interfacial tension. A more positive indication of oxidation is the neutralization number.

Saponification number is figured in terms of the amount of potassium hydroxide (in milligrams) necessary to saponify one gram of oil. It is a test more applicable to lubricating oils compounded with fixed or fatty oils of animal or vegetable origin. In this case it indicates the amount of fixed or fatty oil in the base lubricant.

High saponification number generally indicates susceptibility to emulsification. Where water or moisture is encountered, a high saponification number may, or may not, be desirable. In a hydraulic system it would definitely be undesirable. However, for steam cylinders or wet service in air tools, it would be beneficial as an aid to more positive lubrication. This bears out the importance of considering service and operating conditions when selecting a lubricant.

Saponification number is of value in determining amount of fatty material in soap content of a grease. Where grease is to work in presence of an appreciable amount of water, its solubility-tendency is important. Lime-and-lithium soap greases are relatively nonsoluble in water; the contrary holds true for sodium soap products although viscosity and nature of refinement of mineral-oil content is a factor. A notable example is one of the most widely used greases for automotive chassis service, which is of sodium soap base compounded with a specially refined, relatively high viscosity mineral oil.

Presence of water also makes the emulsification characteristic an important factor. As with saponification, emulsification is most useful in connection with compounded oils where the compound is added to increase lubricating film tenacity by forming an intentional emulsion with water.

Compounded steam cylinder oils are typical of such products and as a rule once-through lubrication prevails; hence, permanence of the emulsion is of little importance. Ready separation from water is advantageous later in the separator or extractor, when the exhaust is to be used in open-type feedwater heaters or for auxiliary heating where compound deposited on interior of heating coils could reduce the rate of heat transfer.

With a soluble metal-cutting oil, permanence of emulsion is important because the oil usually is circulated for reuse.

Demulsibility. Ease of separation from water becomes doubly important where turbine or hydraulic-grade straight mineral oils are involved. Even these highly refined products have a slight tendency to emulsify by themselves when agitated with water. This is not of too much concern, however, provided rate of separation later is rapid and virtually complete. This feature, known as the demulsibility, is the objective of conventional ASTM Steam Emulsion Test. Here an oil sample is emulsified by steam, the rate of subsequent separation being measured in seconds as the SE number.

Rate at which any oil separates from water depends upon the extent and manner of refinement and the purpose for which the oil has been prepared. Heavier or more viscous oils behave like compounded oils: they separate less readily from any contained water.

Emulsification, oxidation. Development of an emulsion in any oil sets up a condition which, regardless of its permanency, may lead to oxidation provided oxidizing conditions prevail. As the latter involves air, heat and the presence of nonferrous metal, such as copper or brass, it is a fairly safe presumption that, if an emulsion persists for any length of time in an oil where emulsification is not desired, oxidation may occur. As oxidizing materials are formed they tend to combine and develop sludge and possibly sticky varnishlike deposits, which can clog oil piping, bearing grooves, strainers and even pump mechanisms.

Of all these methods for predicting the endurance value of a petroleum lubricating oil, the demulsibility test is probably the most practicable and informative for the lubrication engineer or plant operator to work with. Mainly, he should be concerned with the entry of water. If it is not desirable, every effort should be made to keep it out of a circulating system in a turbine, for example, by checking seals, glands and oil coolers for possible leakage. If demulsibility is a factor in promoting lubrication, main concern should be to select a readily emulsifiable oil so the most effectual lubricating film will result.

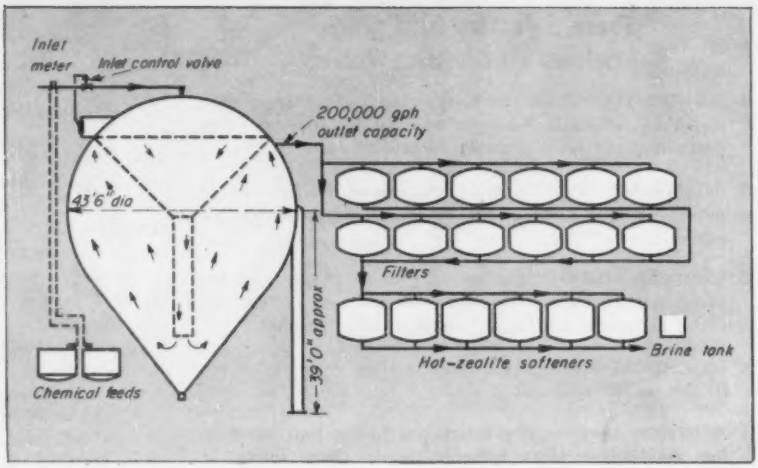
Adhesion is associated with wetting ability in a lubricating film. Between a bearing, shaft or gear-tooth surface

(*Continued on page* 210)

*Definitions are based on the tentative glossary of terms as proposed by the American Society of Lubrication Engineers.

By V J CALISE
Graver Water Conditioning Co

Cost considerations, space limitations, operating attention needed, source and nature of the raw-water supply, results of pilot-plant and laboratory tests. . . . Here's how three refineries took a good look at these items in . . .



1 Small amounts of soda ash along with lime and sodium aluminate are used in the hot-process softener at left. Hot-zeolite softeners contain a styrene zeolite

Finding the right feedwater-treatment

► WHAT FEEDWATER PROBLEMS must your system solve? And how do you go about finding the best treatment to meet these headaches? Let's see how three different refineries tackled it. And how others were able to eliminate filters in some of the feedwater systems.

CASE NO. 1

Raw water for this refinery comes from the drains and a canal. Turbidities and organic matter are as high as 50 to 150 ppm at times.

For many years the plant had to treat this water for low-pressure boilers only. The raw water was introduced into a large number of big, open steel shells. Lime and soda ash were added. Later, the water was heated to 120-130 F and sodium aluminate added. Then it was mixed and allowed to stand. Operators took treated water from top of tanks for use directly in the boilers or for filtering. Treated feedwater had a hardness of less than 5-7 ppm with some soda ash and caustic soda excess.

With refinery expansion, 650-psig boilers were installed. The refinery engineering staff and utilities groups felt they needed a larger, improved feedwater-treatment system. Their first proposal was a 2-stage hot-lime-soda hot-phosphate softener.

Simultaneously, laboratory and pilot-unit tests were being made, which showed that hot-zeolite softeners using a styrene-type cation exchanger had good promise. Tests were for applications above 212 F. Because of these successful tests, the refinery engineers decided to use a hot-lime hot-zeolite system instead of the system first proposed.

As specifications were drawn up for both systems, we can get a good cost-and-quality comparison of the two. System No. 1 shows figures for hot-lime-soda hot-phosphate system. Outlet hardness is mostly magnesium in system No. 1, calcium in No. 2.

	No. 1	*No. 2*
Equipment cost	$350,000	$300,000
Installation cost	200,000	150,000
Total	$550,000	$450,000
Chemical costs per thousand gal water	6¢	4.5¢
Outlet conditions		
Total hardness, ppm	1-2	0-0.5
CO_2 in steam, ppm	10-15	below 6

Fig. 1 shows the system as installed. This hot-process hot-zeolite plant has produced up to 3500 gpm of treated feedwater for more than 27 months with only one scheduled outage. Anthrafilt filters are used. Fig. 3 shows typical results with this system.

Zeolite softeners are regenerated every three or four days using 1850 lb salt per softener per regeneration. Each softener treats 3,000,000 to 3,500,000 gal per regeneration with inlet-water hardness varying between 24 and 33 ppm.

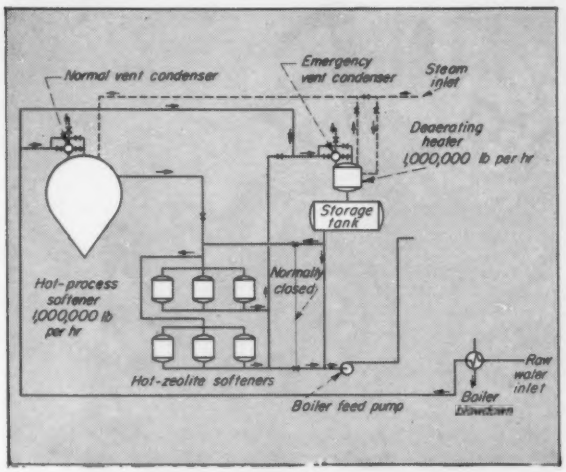
The hot-process softener with downcomer and sludge blanket, shown in Fig. 1, produces treated water containing less than 1-3 ppm of turbidity as measured by the Hellige turbidimeter. During a scheduled inspection, the hot-process softener was bypassed and raw water put through the filters and hot-zeolite units for one week with no apparent effect on plant operation beyond a slight increase in blowdown. Similarly, when the filters were inspected, water from the hot-process softener was sent directly to the hot-zeolite softener with no difficulty other than having to give the zeolite an added middle-of-run backwash during the process.

CASE NO. 2

Raw water for this refinery has temperatures from 150-180 F and is low in hardness. It contains some insoluble waxes and other organic materials picked up in heat exchangers. The feedwater system treats the water for 380-psig boilers.

Prefiltration is a recognized solution for this problem. But lack of space and other considerations called for a more compact design. So it was decided not to use filters if possible.

Refinery engineers ran pilot-plant



2 Filterless system treats water for 850-psig boilers. The hot-zeolite softeners have special sub-surface scrubbers

	CONSTITUENT	PPM as	I	II	III
CATIONS	Calcium (Ca^{++})	$CaCO_3$	62	22	0-1
	Magnesium (Mg^{++})	"	43	4	0-1
	Sodium (Na^{+})	"	29	102	122
	Hydrogen (H^{+})	"			
		"			
		"			
	Total Cations	"	134	128	124
ANIONS	Bicarbonate (HCO_3^{-})	"	44	0	
	Carbonate (CO_3^{--})	"		24	22
	Hydroxide (OH^{-})	"		14	12
	Sulfate (SO_4^{--})	"	48	50	50
	Chloride (Cl^{-})	"	42	40	40
		"			
		"			
	Total Anions	"	134	128	124
Total Hardness		"	105	26	0-2
Methyl Orange Alkalinity		"	44	38	36
Iron, Total		Fe	1.3	-	-
Carbon Dioxide, Free		CO_2	-	0	0
Silica		SiO_2	3.5-4.0	2.5-3.0	2.2-2.8
Turbidity			50-100	1-2	0-1
Color			30-70	0-2	0-2
pH			6.5	10.4	10.3

3 Raw-water content shown in column I, hot-process results in column II, hot-zeolite results, III

system to satisfy plant needs

tests over a period of months using styrene-zeolite softeners. They operated them at various rates and with a variety of regeneration and control conditions. And here are the results of their tests: (1) The resin zeolite could apparently be cleaned free of wax by simple backwashing at both the end of the cycle and several other points in the cycle, depending on the pressure loss or the volume of water treated. (2) Maximum rate of water flow through the zeolite softener should not exceed 5 gpm per sq ft when no filters are used. (3) Sub-surface or rotary surface washers would be extremely helpful in keeping the zeolite beds clean.

Based on the pilot tests, a styrene-zeolite system has been designed and is now installed. The units are equipped with sub-surface scrubbers. A cam-operated time-cycle controller actuates diaphragm-operated valves for backwashing, regeneration and servicing operations. When service cycle is accurately established, controls can be changed for fully automatic operation.

CASE NO. 3

This refinery takes its raw water from evaporators and condensate collectors. The water is highly contaminated with mineral salts and organic materials picked up from its source. Treated water must be suitable for the 425-psig boilers at this refinery.

The condensate raw water is initially treated with lime, caustic and alum in a cold-process softener. After this treatment, the water still contains a large concentration of ammonium ions. It also has iron and weak acid-organic compounds, 4-8 ppm SiO_2 and about 50-80 ppm of mineral cations and anions as calcium carbonate.

Again, pilot-plant tests were made, this time to decide on the best demineralizing system for the above conditions. Tests covered a 6-month period. Various types of cation and anion-exchange resins, and different regenerants and regenerant methods were used during this period. And flow rates and other conditions were varied. From this, sulfuric-acid-regenerated styrene-type cation exchangers and highly-basic anion exchangers were selected.

By using this 2-bed demineralizing plant, the boilers and turbines have been clean for the past two years. There has been no problem with foaming, scaling, silica, etc. Treated water from the demineralizer contains less than 0.5 ppm total dissolved solids measured by conductivity, less than 0.1 ppm of silica and no organic compounds.

MORE ABOUT FILTERS

Filters are always recommended ahead of hot-zeolite softeners. Hot-process turbidities of 10-20 ppm to filters limit filter flow rate to 3 gpm per sq ft in hot-zeolite system. Using modern downcomer hot-process unit, we can get turbidities of 1-2 ppm to filters. This permits us to increase filter flow rate, thus reducing number needed.

A number of hot-process, hot-zeolite systems are operating without filters. Fig. 2 shows one of these systems, the largest in operation at present. It has been running for more than 2½ years, furnishing feedwater for 850-psig boilers. Several other smaller systems have been operating for one or more years without filters.

In all these plants, rotary surface washers or sub-surface washers were included in the original design to aid in removal of accumulated solids on backwashing at the end or middle of the run. All these plants produce feedwater of excellent quality with uniformly-high-capacity cycles.

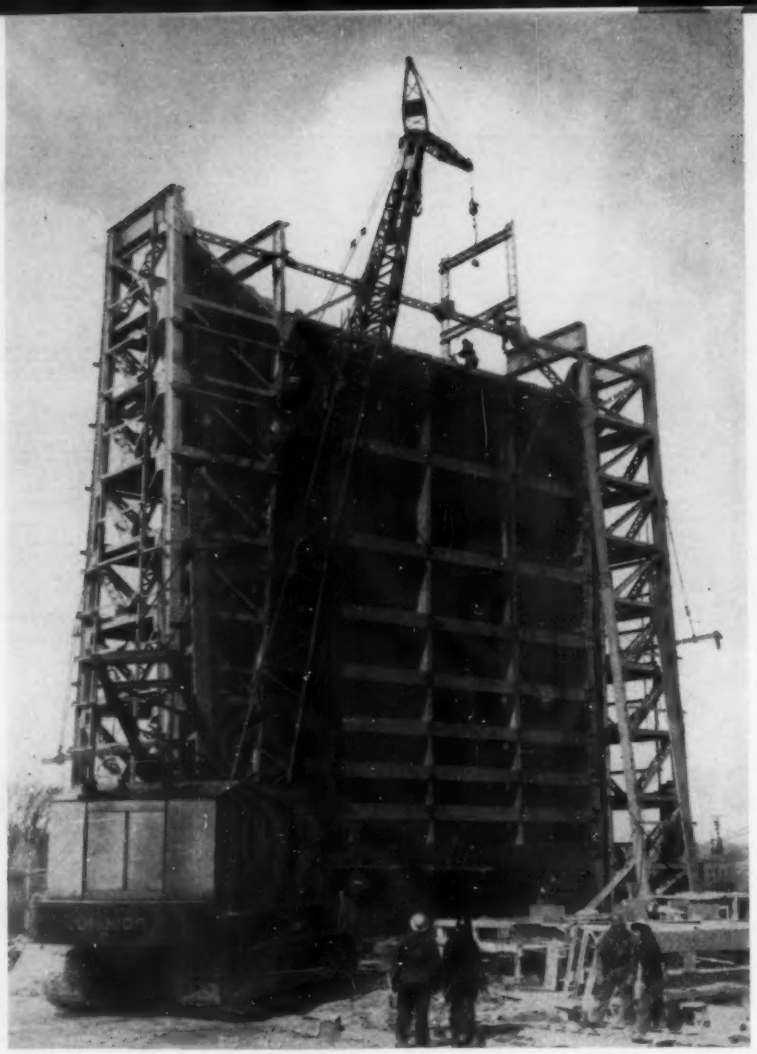
The system shown in Fig. 2 initially had trouble with sticky material adhering to the zeolite particles. Although present in extremely small concentrations, its sticky nature led to accumulation and difficulties in removal. Special sub-surface scrubbers, installed about 9 in. below the top of the zeolite bed, solved this problem. These scrubbers must be used during service run.

On considering filterless system due to space saving, etc, nature of precipitates to zeolite softener is important—often more so than the amount of

(*Continued on page* 224)

225-TON GATES

installed at Niagara Falls



CONTROL GATE built of structural steel is 58 ft high by 45 ft wide. It will shut off water in emergency to one of the two concrete-lined tunnels, 45 ft in diameter

► TWO CONCRETE-LINED TUNNELS, 45-ft inside diameter, five miles long, will supply water for Sir Adam Beck-Niagara No. 2 plant of Hydro-Electric Power Commission of Ontario. They discharge into a canal 2½ miles long leading to a forebay above the plant on the Niagara River near Queenston, Ont. Here, 1,600,000 hp is being installed in sixteen 100,000-hp units to operate under 300-ft head. As part of the project, Dominion Bridge Co Ltd designed, fabricated, erected two of the world's largest hydraulic control gates and hoists.

They are installed in the intake of the tunnels, as in photo, to shut off water at full flow in an emergency. Their operation must be highly reliable for they may not be used for a period of several years. Closing of one or both gates can cause a large loss of plant capacity so will not be considered except when absolutely necessary.

Because control gates of this size have never been built in Canada, the commission's engineers made model studies based on the proposed design to determine lifting loads caused by hydraulic conditions in opening and closing a gate. Also, a study of hydraulic effects in the tunnels resulted in limiting the lowering speed to only 4½ in. per min.

A screw-type hoist was selected in spite of its increased cost, in preference to rope, largely because of the infrequent service. If internal corrosion of the ropes took place, it might not be found until serious failure occurred.

Operating against a head of 56 ft, each gate is 58 ft high, 45 ft wide and weighs about 225 tons. The hydraulic load is carried into the embedded steel guides by 42-in.-diameter fixed-axle rollers supported in grease-lubricated bronze bushings. Gates are basically of riveted steel construction, with certain portions such as the top lifting lugs fabricated by welding, where it proves advantageous. Field joints are riveted and calked where necessary, rather than welded, to avoid any risk of distortion in the structure, which would upset shop assembly and alignment.

A pair of 10-in.-diameter rotating steel screws about 71 ft long lifts each gate. Bronze lifting nuts supported in forged-steel trunnions, carried in the lifting lugs on each side of the gate, transmit the load into the screws. To rotate them, machinery in a fixed structural-steel arch above the gate opening, is driven by a 40-hp motor. This arch, 75 ft high and sheathed in aluminum, is in a public park area. Therefore, to give it a pleasing appearance, it was designed in close cooperation with the Commission's architectural department.

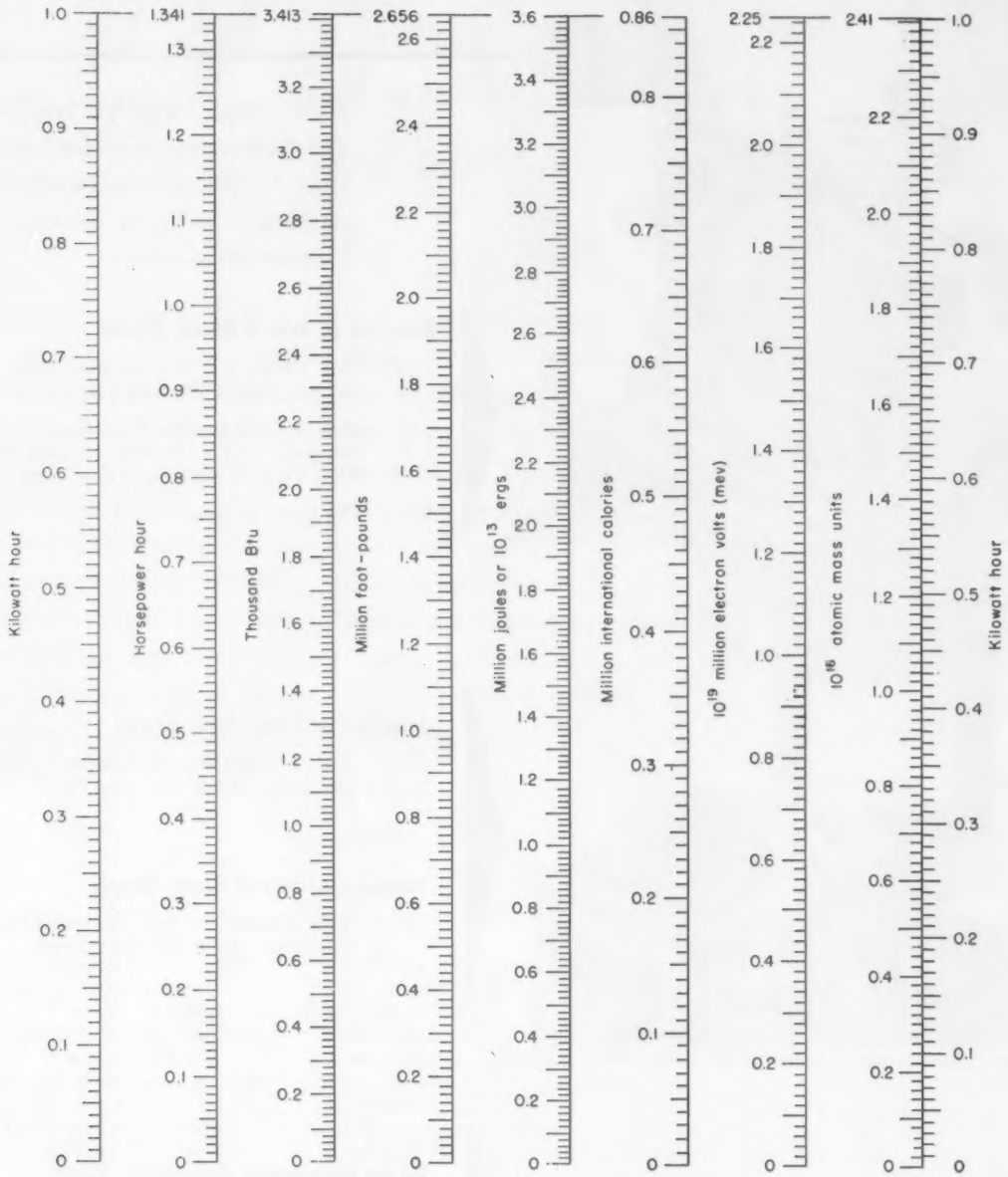
Two sets of steel stop logs for the tunnel are welded-steel construction with rubber seals. Embedded steel checks for these logs were installed upstream from the control gates and also at downstream exits of the tunnels. This permits unwatering the tunnels for inspection and repair.

CORRECTION

May 1954 data sheet 263. Temperature-volume correction formula should read, in part, 1 + C instead of 1 – C.

Power's DATA SHEET

No. 268



Handy energy-conversion chart

► MOST COMMON MEASURE of energy today is the kilowatt-hour. There are many other units that also apply, as shown by the eight scales above. To use: (1) Find known energy quantity on proper scale. (2) Lay straightedge on point. (3) Make sure it's horizontal by getting equal kwhr readings on outer scales. (4) Read energy in units wanted.

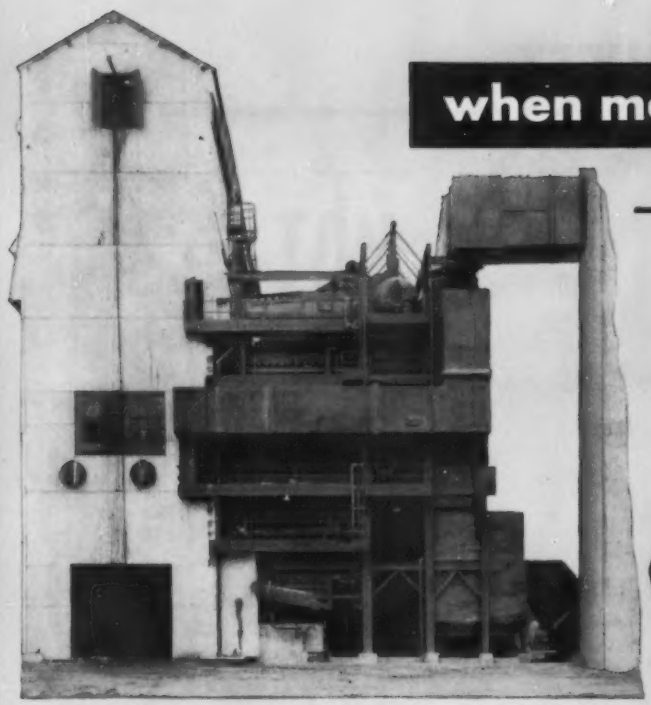
Example: Convert 1400 Btu to other energy units shown.

Lay straightedge across 1.4 on 3rd scale. Read 0.41 kwhr, 0.55 hphr, 1.09 million ftlb, 1.48 million joules, 0.352 million calories, 0.922×10^{19} million electron volts, 0.988×10^{16} atomic mass units. These scales can be used for any range simply by multiplying all of them by, say, 0.01, 10, 100, 1000 or any factor that brings scales within range wanted.

By B G A Skrotzki, Associate Editor

© POWER

when more steam was needed



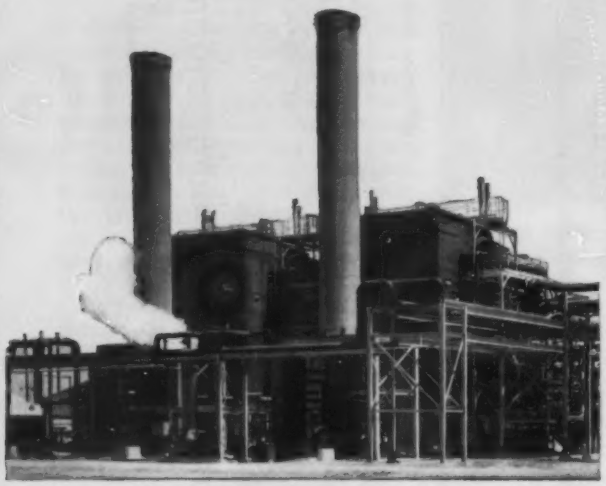
from 1935 to 1954 Shell Oil Company purchased 1,650,000 lbs./hr. steam capacity in Riley Steam Generating Units

Installed at Wood River, Illinois

1935 - One 50,000 lbs./hr. Outdoor Unit
400 psig - 450 F - Natural Gas Fired.

1940 - One 125,000 lbs./hr. Semi-Outdoor Unit.
650 psig - 750 F - Pulverized Coal Fired
Riley Pulverizer - Riley Flare Type Burners

1942 - Duplicate of Above Unit

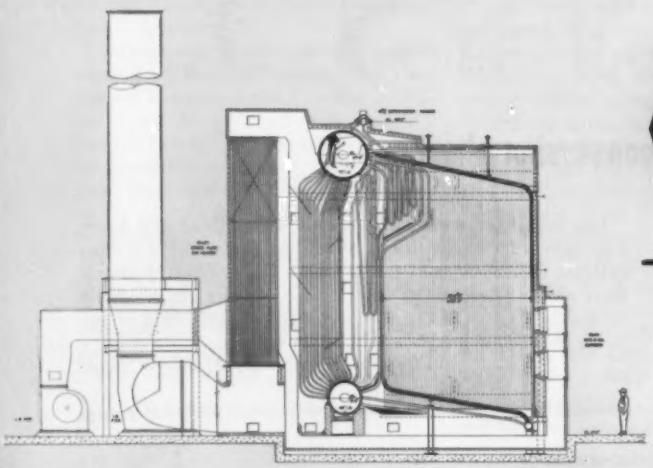


Installed at Deer Park, Texas

1950 - Two 250,000 lbs./hr. Outdoor Units
650 psig - 750 F Oil, Gas Fired

Installed at Wood River, Illinois

1952 - Two 250,000 lbs./hr. Outdoor Units
650 psig - 750 F Oil, Gas Fired



To be Installed at Anacortes, Wash.

1954 - Two 175,000 lbs./hr. Riley RX Type
Outdoor Units
650 psig - 750 F Oil Fired
Bechtel Corporation, Engineers

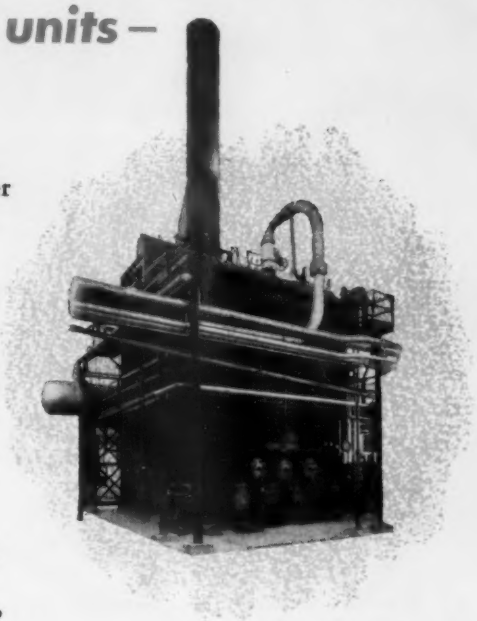
A survey of your power plant by a consulting engineer will possibly show ways of making surprising changes in your power costs.

SHELL remembered RILEY

and ordered its eighth and ninth Riley outdoor units –

Two decades, a significant period in the growth of the boiler industry, have passed since Riley installed this outdoor unit at Shell Oil Company's Wood River, Illinois refinery. Today this compact unit is still perking along, come rain, shine, snow or cold winter winds . . . still producing the 50,000 lbs./hr. of steam, 400 psig, 450 F for which it was designed.

As Shell expanded and added new oil refining and chemical manufacturing facilities, and when new steam generating equipment was specified, Shell power engineers remembered their first Riley outdoor unit . . . its dependability and continuity of operation. Shell's eighth and ninth Riley units will soon be installed at its new plant at Anacortes, Washington.



- 50,000 lbs./hr. Outdoor Unit
400 psig. 450 F - Natural Gas Fired
at Shell's Wood River, Ill. Refinery.

This record of repeat orders for Riley units is sound proof of the dependability of Riley equipment

Hooker Electrochemical Co. - 7 Orders
Celanese Corp. of America - 15 Orders
Dow Chemical Company - 13 Orders
Carbide & Carbon Chemicals - 13 Orders
Allis Chalmers Mfg. Co. - 6 Orders
Central Ohio Light & Power Co. - 6 Orders
Gulf Power Company - 4 Orders
Central Illinois Light Co. - 5 Orders
Houston Light & Power Co. - 9 Orders

Esso Standard Oil Co. - 7 Orders
Iowa-Illinois Gas & Electric - 5 Orders
Interstate Power Co. - 5 Orders
Kennecott Copper Co. - 6 Orders
Masonite Corp. - 6 Orders
Public Service Co. of Indiana - 5 Orders
U. S. Steel Co. - 10 Orders
Swift & Company - 10 Orders
Standard Oil Co. of California - 12 Orders

Otter Tail Power Co. - 6 Orders
Ohio Edison Co. - 4 Orders
Curtis Wright Corp. - 7 Orders
Publicker Industries - 4 Orders
Container Corp. - 4 Orders
Beechnut Packing Co. - 4 Orders
Gaylord Container Co. - 4 Orders
Monsanto Chemical Co. - 4 Orders
West Virginia Pulp & Paper - 5 Orders

RILEY Stoker Corporation

WORCESTER, MASSACHUSETTS

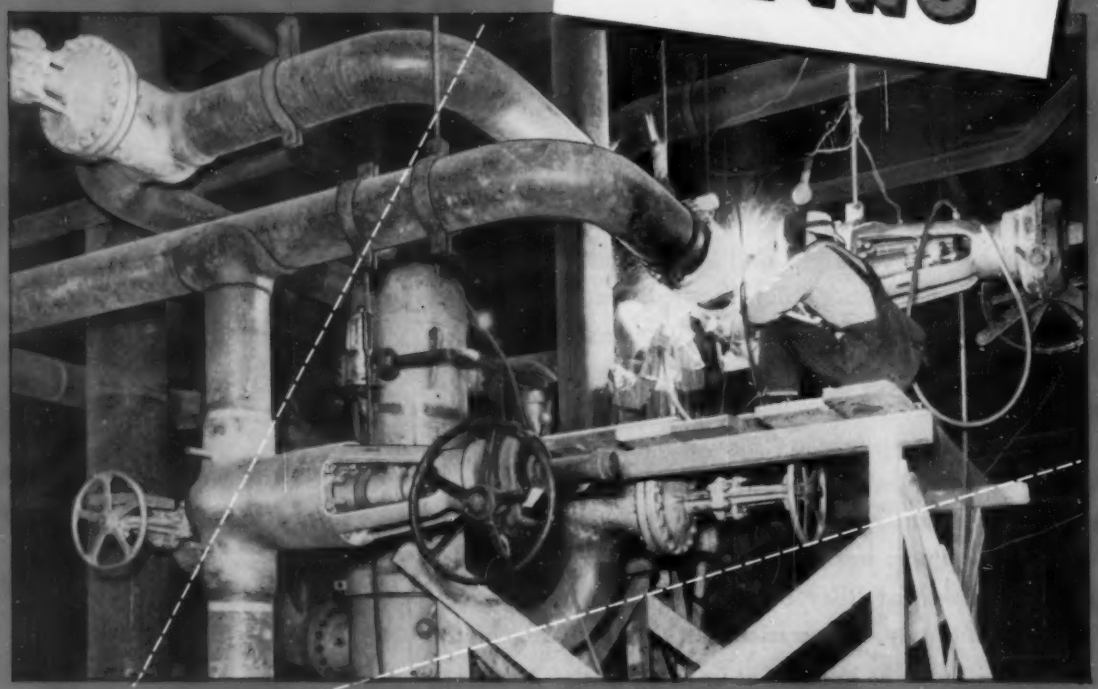
Boston New York Philadelphia Buffalo Washington Pittsburgh Cleveland Detroit Chicago Cincinnati Charlotte New Orleans
Atlanta St. Louis Kansas City St. Paul Tulsa Houston Denver Salt Lake City Los Angeles San Francisco Portland Seattle

COMPLETE STEAM GENERATING UNITS

AND FUEL BURNING EQUIPMENT FOR PUBLIC UTILITIES, INDUSTRIAL POWER AND HEATING PLANTS

THERE IS

MUCH MORE TO MIDWEST PIPING



THAN MEETS THE EYE

Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

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6493

MIDWEST

PIPING FABRICATION and CONSTRUCTION

OFFERS YOU MANY BENEFITS

Today, 'putting-on' tool replaces lost metal

You can replace worn, corroded metal on—1: pump shaft sleeves, 2: steel structures, 3: turbine shafts, 4: coal conveyors, 5: pump impellers, 6: crankshafts, and many other plant items

► WHY SCRAP expensive machine parts just because a few thousandths of an inch has worn off if you can replace the wear? The answer to this question is responsible for one of the most important maintenance tools found in any repair shop.

Metal spraying is the process of spraying molten metal onto a surface to form a coating. Pure or alloyed metal is melted in a flame and atomized by a blast of compressed air into a fine spray. This spray builds up onto a previously prepared surface to form a solid metal coating.

Because the molten metal is air blasted, object sprayed doesn't get very hot, so method is known as the "cold" process, by industry in general.

Sprayed metal is a new metallurgical

EDITOR'S NOTE: Based on information and photographs from Metallizing Engineering Company, Inc, Long Island City, New York.

Worn crankshaft comes to life . . .

as does pump shaft . . .

and impeller

Here are some of many jobs that are done every day

material with physical properties entirely different from those of the metal before spraying. It is generally harder, more brittle and more porous than the original. It has excellent bearing characteristics because of oil retention in pores of the metal.

Equipment needed. 1: Air compressor 2: air-control unit with filter and regulator 3: steel bottles or other source for oxygen and acetylene 4: gas-control unit of oxygen and gas-pressure regulators 5: gas-flow meter 6: wire-control unit for handling metal wire to be sprayed and 7: gun and hose for spraying metal.

Surface preparation. Usually metal is either undercut to receive sprayed metal, heated, roughened, or sprayed with bonding wire. Bonding wire adheres to a smooth, clean metal surface. Then any other metal can be sprayed over it for building up worn or corroded area.

To show what industry is doing with sprayed metal, we tracked down a few jobs that should give you ideas.

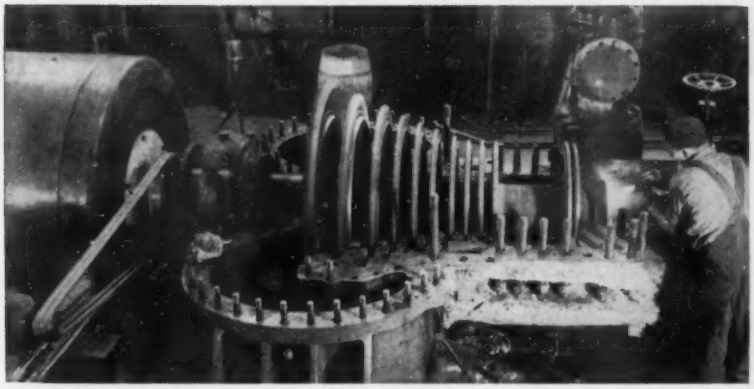
Sprocket shaft. Bearing surfaces of 44-in.-long coal-conveyor sprocket shaft wore badly. The 100-ft-long conveyor moves bituminous coal, feeding two stokers and two pulverized coal-fired boilers.

Worn bearing surface, 8 in. long, was undercut 1/32 in. Flash coat of ⅛-in. bonding metal was sprayed on. With same gun, 2 pounds of 3/16-in.-diameter metal was sprayed on 1/32 in. thick over original diameter. Shaft was rough-turned in lathe and ground to original 3-in. diameter, making finished job cost much less than new shaft.

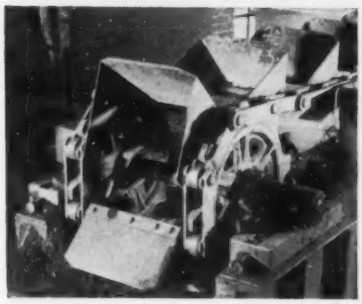
Sump-pump shaft. Three-section stainless-steel shaft for sump pump serves furnace ash-disposal system in the same plant. Ashes from furnace combine with water and carry through lines to settling base. Pump supplies 120-psi water through two ejectors from settling base to place of disposal.

Shaft is below floor in three sections. Wear was on eight bearing contact surfaces and one metallic packing area, and it made shaft wobble badly. Packing caused most trouble, cutting grooves a quarter inch deep. So every few months pump had to be overhauled, taking a 3-man crew three days' time. New 3-section shaft cost $278, and delivery time was four months.

Shaft was sprayed with metal three years ago—has not been touched since. Packing area on upper section and four bearing areas on center and lower shaft sections were built up by spraying. First, all worn areas were undercut 1/32 in. Packing contact surface was sprayed with one pound of ⅛-in. bonding metal to slightly more than original diameter. Remaining four bearing surfaces were sprayed and built up over original di-

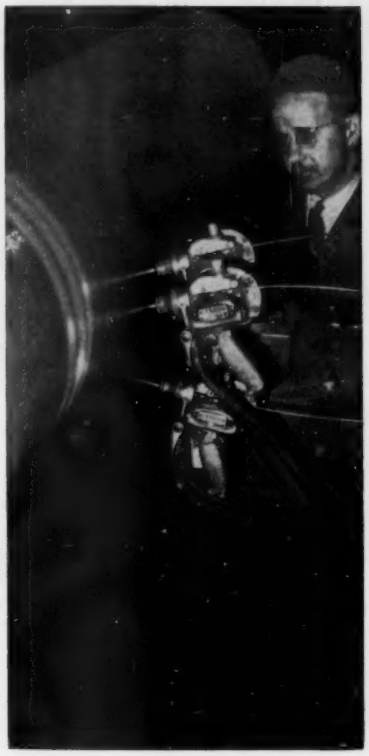


Rotor shaft is built up in place



Sprocket shaft

Pump rod



Three-gun job here

ameter. Each of five sprayed areas was rough-machined and ground to original diameter.

Reason spraying outlasts original shaft is that metal is now porous and retains lubricant in critical bearing areas.

Steam turbine in photo is 25,000 kw. Shaft area through sealing glands was worn. First, a bracket was attached to turbine casing and a cross-feed attachment from lathe bolted to bracket.

With motor shown driving turbine with temporary V-belt hookup, shaft was undercut in gland areas with lathe cross-feed. Then undercut was made rough with a special tool that looks something like a knurling tool. Next, shaft was sprayed with stainless-steel alloy and sprayed sections were finished by turning with lathe cross-feed.

Without this "putting-on" tool, turbine shaft overhaul would be a very expensive repair for entire rotor would have to be removed from housing. Rotors may have to be heated and removed from shaft. And shaft may have to be turned down for sleeve or even replaced with new shaft as sleeves are not too practical on turbine shafts.

Breast roll in paper mill was 22 in. in diameter and 13 ft, 7 in. long. Because entire surface was turned down and had to be built up with sprayed metal, three guns were used to save time. Photo shows guns staggered so each builds up sprayed metal of about 0.002 in. thickness. In this way lathe carriage does three times as much work each time it feeds from one end of shaft to other.

Replacement cost of large parts like this is very high and spraying worn surfaces often helps put machinery back into operation over weekend, in much less time than new part could be machined or received from maker.

Pump impeller is often shot-blasted and volutes sprayed with gun having special attachment to reach inside of volutes at right angles. Spraying with stainless steel not only builds up eroded areas, but also protects impeller against erosion and corrosion. Coating of from 0.005 to 0.010 in. thickness is about right. Wearing-ring section of impeller is also built up and machined so it has right clearance when impeller gets worn and loses efficiency.

Tanks and machine parts subject to corrosion are often sprayed with about 0.010-in. coating of aluminum, after blasting with silica sand. This treatment is also used where ferrous metal might contaminate distilled water or condensate for boilers, foods or chemicals.

Outside surface of a steel structure is also sprayed with aluminum instead of paint because of the permanence of the aluminum coat compared to paint.

Fusing. Sprayed metal is not fused to base metal as is a welded deposit. But it can be fused in various ways. Most small to medium-sized work may be fused with an acetylene torch, and larger work with two or more torches used at the same time.

Cylindrical shapes, such as shafts, rods and bushings, may often be fused while rotating in a lathe, which tends to reduce warpage. When torch-fusing, it's best to preheat the work from 600 to 1000 F by passing the torch or torches back and forth over the surface from a distance of several inches.

Torch tip should then be moved up to within 1½ in. of surface, starting at one end of sprayed section and moving as fast as coating becomes fused. You easily know fusion point because it has a gloss or shine. Plastic range of deposit is between 1850 and 2050 F. Putting-on tool can save you money.

OPERATORS' NOTEBOOK 79

Watch boiler inspector

1 How do you go inside the steam drum? That depends on many things. Here the inspector goes in head first. Take only low-voltage electrical equipment inside

2 Check shell carefully for corrosion, such as pits, by tapping with hammer

6 Small holes in dry-pipe top and tiny drain-holes at bottom must be free

7 Head seams in drum often groove or corrode. Check all suspected spots

8 Openings in drum for water column must be free. Watch lower hole

► REGISTERED POWER BOILERS must be inspected at regular intervals, says the National Board Inspection Code. Owner or user has to prepare boiler for inspection when notified by inspector.

Beforehand, boiler must be opened and prepared for internal and external inspection. Caution! In cooling down a boiler, don't dump water until unit has cooled slowly, or you will damage settings and the tubes. Let it cool down naturally, if possible. Remove all manhole plates and other openings.

If deterioration of inaccessible parts is suspected, you may have to remove insulation material, masonry or fixed parts of boiler. Where moisture or vapor shows through covering, remove covering for inspection.

Inspector must get as close to boiler parts as possible with strong light. If attachments or apparatus need testing, plant operator does it in inspector's presence if he orders it.

How to prepare boiler for inspector. 1: Dump water and wash waterside with hose. 2: Remove manhole and handhole plates, wash out plugs and water-column connection. 3: Clean furnace and combustion chambers, blow soot from tubes and all surfaces to be inspected. 4: Remove fuel grates. 5: Remove section of brickwork if ordered by inspector. 6: Remove steam gage for testing. 7: Disconnect pipe or valve if steam or water leaks into boiler.

Certificate of Inspection can be withheld by inspector until boiler is properly prepared. You might have to remove enough jacketing or setting along longitudinal seams of shells, drums or domes so he can inspect rivets, pitch of rivets for data needed in determining safety of boiler. Or you might have to drill suspected thin spots at his request so he

check your boiler's waterside: I

By **STEVE ELONKA**, *Associate Editor*

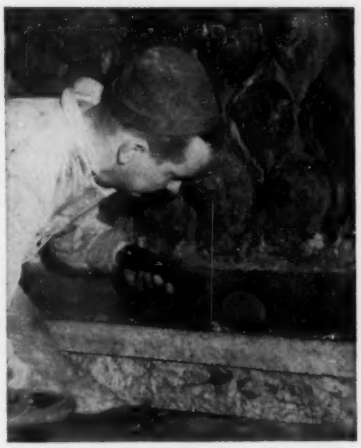
3 Look into all downcomers at drum's rear for scale, also condition of tubes

4 Upcomers under baffles may corrode or have scale deposits. Hammer test

5 Inspect longitudinal seams inside the shell carefully for corrosion as here

9 Check manhole plate for corrosion on seat, also cracks from bellows effect

10 Tubes' inside headers may be heavily scaled. Check lower tubes well



11 Mud-drum header may be badly scaled. Check condition of scale

can gage thickness for possibly reducing steam pressure in older boilers.

Here are inspector's internal checks:

Scale, oil, etc. Inspector examines all surfaces of exposed metal inside to check action caused by water treatment, scale solvents, oil or other substances that might have entered with feedwater. Oil inside a boiler is dangerous; you must prevent more entering at once. Oil or scale in tubes of watertube boilers or on plates over fire of any boiler weakens metal, causing bagging or rupture.

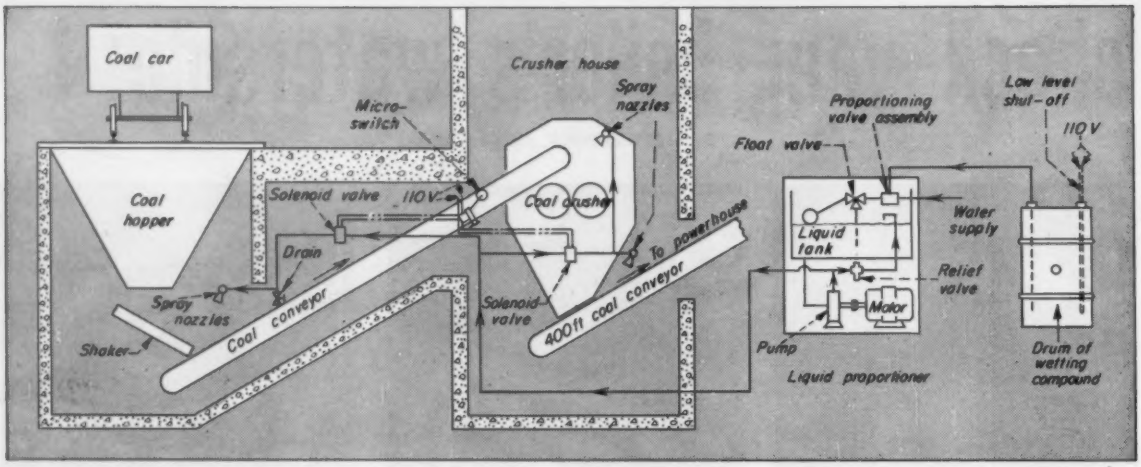
Corrosion along or next to a seam is more serious than in solid plate away from seams. Strength of longitudinal joint is less than solid sheet, so thinning here is dangerous. Severe corrosion is likely where water circulation is poor. Inspector checks these places.

Grooving and cracks along longitudinal seams are bad because they usually occur when material is highly stressed. Internal grooving, in fillets of unstayed heads, and external grooving, in outer surfaces of heads concave to pressure, are common because of slight movement in heads.

Stays are inspected for even tension, fastened ends are examined for cracks where stays are punched or drilled for rivets or bolts.

Manholes and other openings are examined internally and externally for deformity or cracks. Opening to water-column connections, dry pipes and safety valves must be free of obstructions, such as mud, scale, etc.

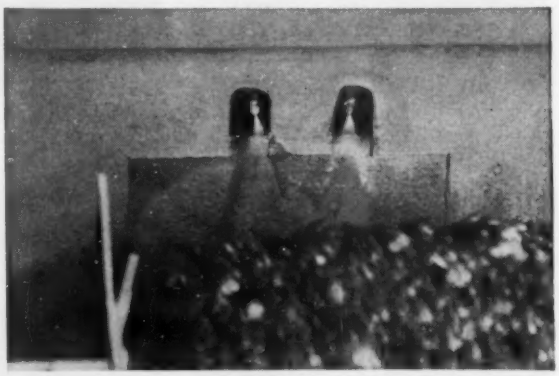
Ligaments between tube holes in heads of all boiler types often crack, then leak and weaken boiler. Also check beading on tube ends for erosion and corrosion, especially in type of boiler here. Remember, the cleaner the boiler, the better job the inspector does.



WETTING SYSTEM mixes water and wetting compound, pumps mixture to spray nozzles before and just after the coal crusher

Cut that coal dust at small added cost

By R P PFEIFFER, *Power Engineer, Hiram Walker & Sons, Inc*



MIXTURE sprayed on coal maintains dust-free atmosphere as coal goes to crusher. Wetting agent permits complete wetting

► WE HAD A COAL-HANDLING PROBLEM in our powerhouse at the Hiram Walker Peoria Distillery: coal dust and spontaneous combustion in the bunkers. Combustion controls, smoke indicators and dust collectors take care of air pollution. To give us a completely "clean" coal-firing system, we had to lick the coal-dust problem.

One possible solution for the dust nuisance would have been to completely enclose the coal system. But this would not have eliminated the possibility of dust explosions or spontaneous combustion in the bunkers. And, besides, enclosing the system would have been almost impossible as well as prohibitive in cost.

Coating coal particles with a thin film of water would have solved all the problems. But spraying water alone on coal is like pouring water on a duck's back. Something is needed to make the water stick.

We found a wetting agent that does the trick. By adding a small amount of the agent to water, and spraying the mixture on the coal, we now make the coal-handling operation dustless. And moisture stays on the coal particles even after long periods in bunkers, giving dust-free handling to boilers and preventing spontaneous combustion in bunkers.

Wetting system. Installation cost was a minimum as a manufacturer supplied the wetting system built into a self-contained unit.

Referring to the drawing at top of page, a small motor-driven pump takes suction from the liquid tank, discharging either to the three sets of spray nozzles or through the relief valve. Mixture going through the relief valve returns to the liquid tank, thus giving recirculation of the mixture. Float-operated valve maintains desired level in the liquid tank. As float goes down, replacement cold water passes through an injector-type proportioner to the tank. The injector draws a small amount of wetting agent from the storage barrel to mix with the water in the desired proportion.

Mixture to the spray nozzles passes through the two electric solenoid valves shown. These valves open and close on an impulse from the feeder-belt-operated microswitch. Weight of the coal depresses the microswitch, causing the valves to open. With no coal on feeder belt, solenoid valves remain closed. In this way none of mixture is wasted.

Operation costs are low. The pump motor is small. And we use only two gallons of water per ton of coal. A gallon of wetting agent is fairly expensive. But we need one part of the agent to every 700 parts of water. So it turns out that the wetting agent costs only 0.2% of price of the coal processed.

The weight of water added is only one percent of the weight of coal as unloaded. This is within the variance of moisture content of coal as received.

5 timely Q&A on diesel engines to help you do a better operating job

By JOHN BAKER, *Chief Engineer*

1. What is meant by cetane number of fuel oil?

A. Cetane scale is applied to fuel oils, gasoline, diesel fuel, etc, to show oil's ignition quality. This quality means oil's ability to ignite in diesel cylinder —or under similar conditions. Fuel with good ignition quality will auto-ignite at low temperatures and is, therefore, preferred. This quality affects engine starting, smoking and knocking.

Hydrocarbon family ranges from simple combinations, such as methane gas, through various solids, liquids and gases. Some have complicated chemical structures. All have various ignition characteristics. Formula for cetane is $C_{16}H_{34}$.

Cetane is an excellent diesel fuel in its pure form, but isn't easy to separate completely from other hydrocarbons. Cetane content for various crudes differs greatly. $C_{10}H_7CH_3$ is another hydrocarbon, but it has poor ignition qualities. Cetane number is based on proportions of these two hydrocarbons.

Cetane number of 100 means ignition quality equal to pure cetane, while zero means one equal to that of alpha-methylnaphthalene ($C_{10}H_7CH_3$). Ignition number of 60 means mixture equivalent to one composed of 60% cetane and 40% $C_{10}H_7CH_3$.

2. How is cetane number determined?

A. Ignition-delay method on single cylinder test engine is used to determine cetane number. Fuel to be tested is used in engine, and compression ratio is raised until ignition-delay reaches a standard length. Poor-quality fuels' ignition quality needs a high compression to shorten the delay period, while fuels of good quality take lower compression for the standard delay.

Once compression ratio for test fuel is found, various mixtures of cetane and alpha-methyl-napthalene are burned. From this, compression ratio needed for each fuel, to bring delay period to standard figure, is found.

Cetane number of test fuel equals percentage of cetane in mixture that requires same compression ratio as test fuel, to produce standard delay period.

3. What is meant by right- and left-hand engines. Buyers ordering two engines for same plant often specify one each. Is this good practice?

A. Engine is classified as right or left when flywheel is on right or left sides, viewing engine from operating side. Reason one engine of each is specified is because owners believe such an arrangement is easier to attend if controls are on same aisle between engines.

Diesel Engine Manufacturers Association says there may have been reason for such an arrangement years ago before the days of remote governor control, but not with today's common use of such control and the little attention modern engines need.

Such specifications require one engine to be nonstandard. Disadvantage to owner is loss of interchangeability, which is so important to avoid carrying large stocks of spare parts. Then, again, any advantage is lost if a third diesel is installed.

4. If engine fails to start, what would you look for?

A. Engine rarely fails to start, but such difficulty can be divided into two groups: (1) Starting mechanism fails to turn engine through an operating cycle. (2) Engine turns through operating cycle but fails to fire. If starting mechanism doesn't work, check starting air-pressure or look for rundown or weak battery—depending on starting system.

If air-starting pressure is high enough, air-starting valves may not open fully or at right time. Or by sticking, leaky exhaust or inlet valves may prevent engine from quickly raising compression high enough to fire. Leakage from stuck rings or badly grooved cylinders may have same effect. In cold weather, heat of compression may be too low unless cooling water and (in extreme cases) even lube oil are heated.

At times, bearings are too tight (after overhaul) or there is no lubrication on cylinder walls, etc. All this puts extra load on starting mechanism.

5. Should operators spend time listening to diesel engines to become familiar with normal noises so they can tell when unusual sounds develop?

A. Yes. It's good practice to spend a few minutes each day listening to natural beat of engine. Listen at each cylinder to detect knock in crank, wrist pin, etc. Also, listen to gear train or to drive chain. Backlash in gears and sprockets can be detected, also loose chains.

Listen for vibration at supercharger. Vibration is caused by dirt on impeller, too much bearing clearance or increased end thrust. To avoid supercharger trouble, run a spin test every six months. Just remove supercharger silencer and spin air rotor by hand. If there's noticeable drag, dismantle supercharger. Usually all that it needs is just a good cleaning.

Change in air manifold pressure at given load shows supercharger needs attention. Trouble may be air leaks in intake connections. Watch air-manifold pressure, or engine will starve for air—causing many headaches for you.

MAJOR OVERHAULS are planned well in advance, timed to avoid production losses

Looking for a practical electrical

General Electric spells out the essentials, adding up to what they call Productive Maintenance. Briefly, their 5-step plan is simply a grouping of field-tested ideas into an organized maintenance program that is bound to pay off in your plant

► TODAY'S plant operating men are taking a hard look at electrical maintenance. Reason: Maintenance costs in general have zoomed some 45% since 1947, and electrical upkeep is accounting for a large share of this increase. The smart approach now is to carefully plan each step in your program and determine whether the scheme as a whole is really paying off. In brief, that's the theme behind GE's *Productive Maintenance* program, now gathering steam after being introduced in Cleveland a few months back. Let's review some of the highlights of this program. It will serve as a good refresher for the old-timers and an education for the youngsters getting their feet wet in this expanding field of plant maintenance. (Industry in the next ten years will double its maintenance expenditures to 22 billion dollars annually.)

The broad view. In plant after plant throughout the country, engineers are lifting plant output figures by adding motors with higher ratings, more complex control, new electronic equipment, and various other devices. All this is being done to reduce the direct labor content of the finished product. But if this added, and more expensive, equipment, which requires highly skilled and well-planned maintenance, is not kept in something like continuous operation, most of the intended benefits are lost. Idle machinery costs real money.

Survey your electrical equipment: know what you have, where it is. That's the first step: Get on close terms with your plant's electrical equipment. To identify each unit, assign an inventory number. Generally a number system is used to indicate building, floor, and machine number. Put that number on the equipment or machine so it can be readily spotted.

Simplify the job by using record sheets or cards listing general data required and any special info needed. Try having a maintenance clerk fill in these cards so he'll be familiar with all electrical equipment in the plant.

A well-edited record card includes a description of the equipment, applica-

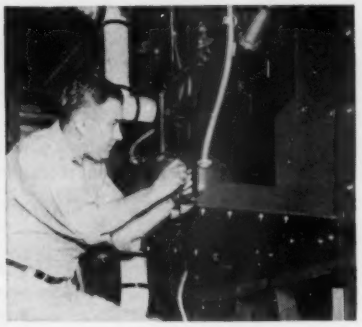
Follow these 5 steps: The key to effective electrical maintenance

1 Get full equipment data

2 Plan routine maintenance

5 Plan critical maintenance

3 Establish a control system



4 List all critical equipment

maintenance program? Here it is!

tion, rating, serial number, manufacturer, vendor, purchase-order number, cost, rating, and machine or equipment number. Provide space on the record card so the original location of the unit and later changes may be recorded.

These cards can serve as plant property records. You can improve the record sheets by compiling an index of equipment by class or type. The index also provides an easy way to find the total number of units of any item.

How far can you go with routine maintenance? This is a factor that has gone through a cycle in the minds of many engineers. In the early days, shortly after World War I, little was done in the way of extensive maintenance. Then, again, equipment was relatively simple in those days, hence required less attention. About the time of the great depression, plant men started extensive maintenance schemes to squeeze the last gasp from machines.

The approach today is to determine not the largest but the best or most desirable amount of maintenance required for the electrical system. Only those items are included that will pay off, or make workers safe. The complete maintenance job is fast passing as being unnecessarily expensive.

Set up inspection schedules, work orders, and renewal-parts stocking system. Up to this point, we've spoken about setting up a card-record system and an inspection cycle that strikes a balance between "too often" with resultant waste of money, and "not often enough" with the possible damaging outages that can occur. Use the repair record to tell if more attention is needed. Also, have your maintenance men who handle inspections note on their report forms whether they feel the maintenance frequency can be cut down.

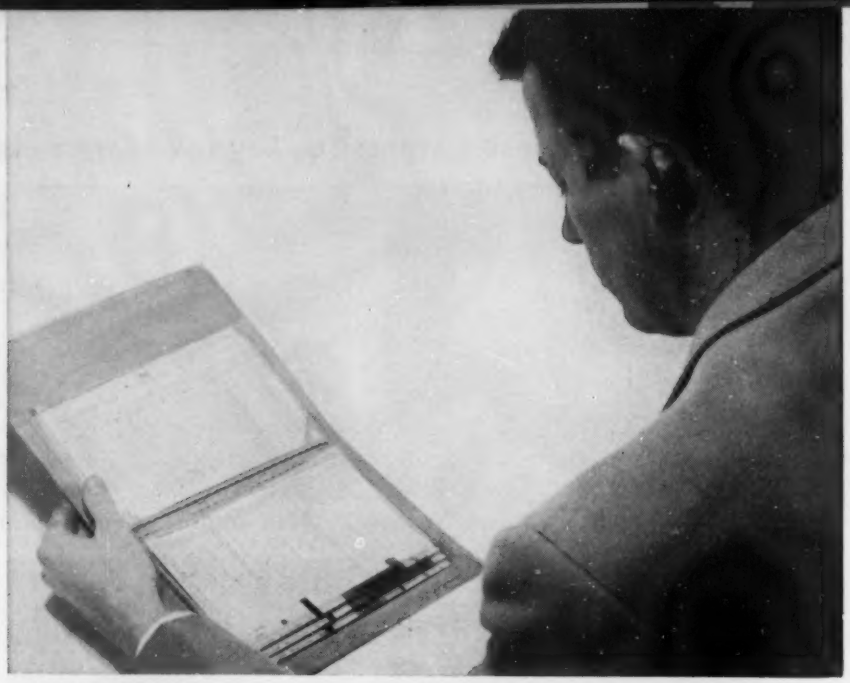
Many of the larger plants have a special group of maintenance men who do not do any actual repair work. Their job is to inspect equipment for repair needs without interfering with production. Have these inspectors work on a schedule, following a set of instructions or check sheet. Their reports start the ball rolling toward prompt repairs.

Work-order program. After using the equipment records to set up an inspection system, dig into the job of establishing a work-order program for routine maintenance. Actually, there's no suitable program that fits all plants. Study the patterns and systems used elsewhere and then work up your own.

Streamlining your work-order system can have a big effect on maintenance costs. Example: One company clipped 23% off its emergency-repair costs and 14% off its routine maintenance costs by revamping its work-order form and work-order system. These savings came about even though the system, before change, appeared in good order.

Look upon a work order as a bid

A streamlined paper-work scheme lies at the base of every modern money-saving maintenance plan



INVENTORY CARD SYSTEM helps keep track of growing number of relays, switches, timers, electronic tubes. And these new additions do not displace existing stock

for action. It should include the job number, job location, department number for charging purposes, craftsmen required, job urgency—date required, description of work needed, cost estimate—labor and material, actual costs and, finally, spaces for approval.

Have work orders list only the essential information. Make them complete enough to rule out additional inspection before any actual work is started. You can also use the work order to indicate to the men doing the job what safety precautions should be taken. Remember that the maintenance man is always faced with the production department's reluctance to stop the equipment—and if this information is included on the work orders, the argument is transferred from the maintenance and production men to the supervisors.

No order, no work. Your first rule on this work-order business should be: *All work done by maintenance must be covered by a work order.* Where written orders are neglected, work is often called for that is unnecessary, improper, or that has already been requested. At other times, orders are issued for work that should be done at some other time because the proposed job relates to a larger job being planned. A written request lets you screen out unimportant or unnecessary work. In an emergency, it may be necessary to make out the order after the work is started. But always make one out.

There are several advantages to a smooth-functioning work-order system. First, you get fewer upsets in scheduling. The number of "urgent" orders is reduced. Second, make-ready is cut down. You lose less productive time in getting at the work each day. Finally, work is finished faster.

Stock parts. Ask your electrical equipment manufacturer to supply you with his recommendation of what renewal parts to stock. Often your own experience with certain equipment is invaluable. For example, the equipment may be in an area where there is a corrosive atmosphere. Here you may want to beef-up the manufacturer's recommendations on spare parts to carry. In other cases, you may know that a local parts-distributor carries the parts required for the routine maintenance of certain equipment. Then your stock can be maintained at a lower point.

Decide what equipment is of vital importance. Then determine its condition and the production cost if it failed. Now you are ready to establish and evaluate critical parts. First, prepare a list of critical equipment. Get close cooperation between maintenance and production departments on this step. Together, these two groups must evaluate the real importance for all electrical equipment in the maintenance setup.

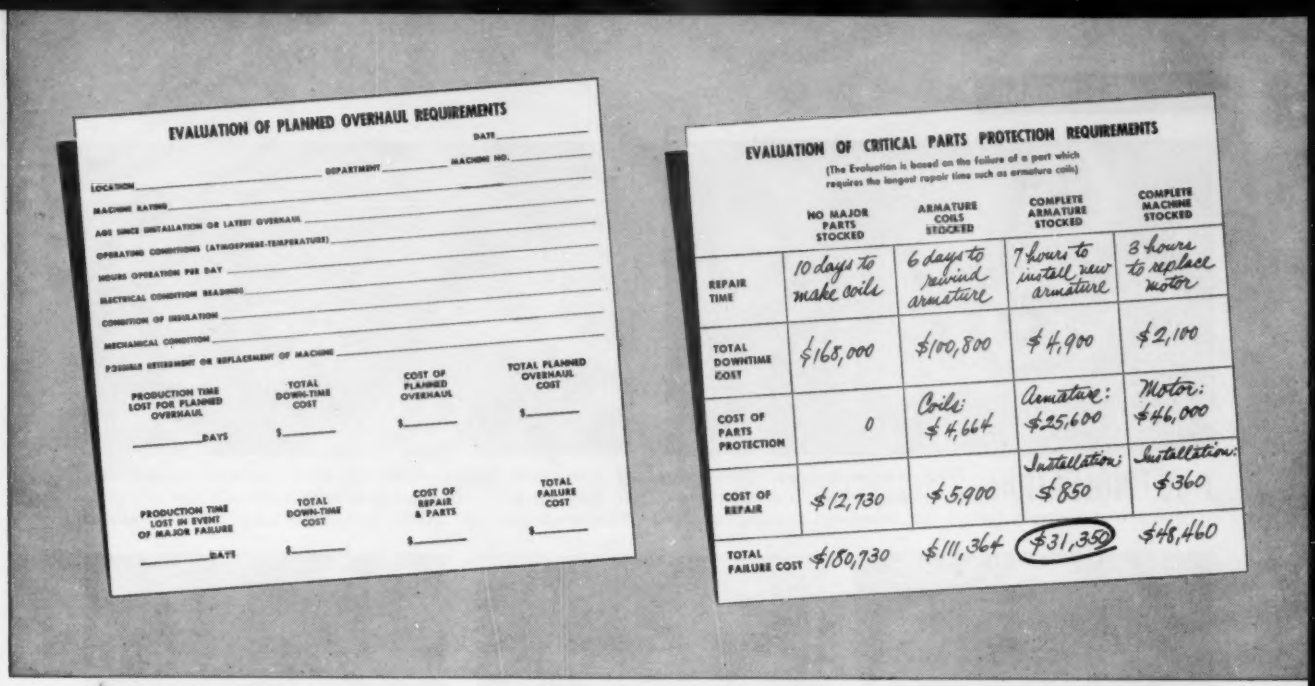
Consider equipment vital if its failure directly or indirectly interrupts or delays production. Juggle here such things as percentage of utilization and lack of bypass equipment. Set up your planned overhaul program in the order of critical importance.

Check critical equipment. When making a complete inspection of critical units it's often wise to call in your equipment supplier. Take advantage of his wide experience with his equipment under every operating condition. Check into the age of each critical machine since original purchase and since last major overhaul. Some insurance companies consider a machine, operating 20 years since purchase or last rewind, a poor insurance risk.

Visual and electrical inspections and tests on machine windings cannot determine the true condition of inaccessible windings. Even a machine kept clean, with windings periodically varnished, and given good routine maintenance, is still subject to turn-to-turn short circuits, open-circuiting or grounding of the conductors.

Ring in the machine duty-cycle, surges, and overloading. All these points contribute to the oxidation of the materials used in winding manufacture. Based on this inspection make a list of machines where probability of breakdown is high. You'll need this information to set up a planned overhaul schedule, as discussed below.

Failure cost. Now try to determine which special parts you need to stock as insurance to protect highly critical equipment—parts whose use cannot be predicted, such as spare armatures, large coils, complete motors and devices. Here's the best way to go about this. First, decide which parts are most subject to failure. Then calculate the repair time, assuming major failure, if:



EVALUATION OF PLANNED OVERHAUL REQUIREMENTS

DATE

LOCATION _____ DEPARTMENT _____ MACHINE NO. _____

MACHINE RATING

AGE SINCE INSTALLATION OR LATEST OVERHAUL

OPERATING CONDITIONS (ATMOSPHERE-TEMPERATURE)

HOURS OPERATION PER DAY

ELECTRICAL CONDITION READINGS

CONDITION OF INSULATION

MECHANICAL CONDITION

POSSIBLE RETIREMENT OR REPLACEMENT OF MACHINE

PRODUCTION TIME LOST FOR PLANNED OVERHAUL	TOTAL DOWN-TIME COST	COST OF PLANNED OVERHAUL	TOTAL PLANNED OVERHAUL COST
_____ DAYS	$_____	$_____	$_____

PRODUCTION TIME LOST IN EVENT OF MAJOR FAILURE	TOTAL DOWN-TIME COST	COST OF REPAIR & PARTS	TOTAL FAILURE COST
_____ DAYS	$_____	$_____	$_____

EVALUATION OF CRITICAL PARTS PROTECTION REQUIREMENTS

(The Evaluation is based on the failure of a part which requires the longest repair time such as armature coils)

	NO MAJOR PARTS STOCKED	ARMATURE COILS STOCKED	COMPLETE ARMATURE STOCKED	COMPLETE MACHINE STOCKED
REPAIR TIME	10 days to make coils	6 days to rewind armature	7 hours to install new armature	8 hours to replace motor
TOTAL DOWNTIME COST	$168,000	$100,800	$4,900	$2,100
COST OF PARTS PROTECTION	0	Coils: $4,664	Armature: $25,600	Motor: $46,000
COST OF REPAIR	$12,730	$5,900	Installation: $850	Installation: $360
TOTAL FAILURE COST	$180,730	$111,364	$31,350	$48,460

DOLLAR COMPARISON is made for critical equipment showing the cost of planned overhauls vs the cost of possible failure

STOCK NEEDED for lowest cost protection of critical equipment can be determined after comparing costs as shown above

no major parts are stocked, some major parts are stocked, all major parts are stocked, complete unit is stocked. Determine the cost of repair and inventory for each of the possible conditions. Then tally these figures to get the total cost of failure. Finally, study over-all cost for each condition to find out just what you must stock to protect the equipment.

Any answer you arrive at will depend on the specific production operation. Then this answer will give you the greatest assurance of continuous production. The table above covering evaluation of critical parts is an actual case study. The motor involved was a 500-hp slow-speed dc motor on a critical machine in a large Western paper mill. Problem was to determine how much an armature failure would cost. Downtime was estimated at $700 per hour. Based on this study the paper-mill plant decided to stock a complete armature for the best protection.

Establish a maintenance program for your critical equipment. There are two ways to trim downtime costs—stock critical renewal parts and schedule overhauls well ahead. Briefly, the setting up of a maintenance plan for critical equipment is the action step in this whole plan.

Which parts are most important? Get them first. Then organize your budget so you can purchase the rest of your critical stock on planned basis. Remember, too, that your critical equipment demands a more rigid schedule of inspection and service. Maintenance schedules must be more complete. Furthermore, you must keep closer records of all operations, failures, maintenance and operating costs.

Planned overhauls. Schedule planned overhauls well ahead so all necessary men, tools and materials needed are on hand at the proper time. Set overhauls for normal downtime, vacation closings, holiday shutdowns, and for off-season production periods. Aim for the least disruption in plant production.

Scheme for planned overhaul works best after equipment has operated over a reasonable service life. It works this way. On a systematic basis, remove the electrical equipment that needs overhaul most, or is most important for plant operation. Select the most favorable time from a plant-production angle for complete rewinding, rebuilding or modernization. These planned, short-term outages consume far less time than the unplanned shutdowns they eliminate or minimize. As a result, the gap between actual and theoretical maximum production on the part of any machine is narrowed.

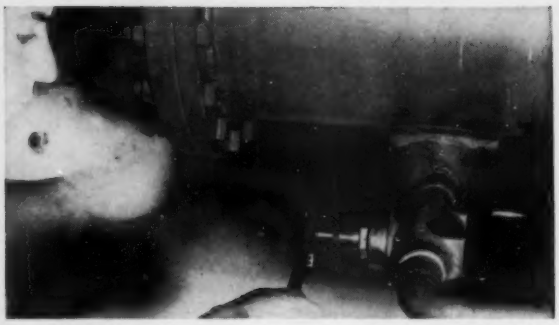
Also, in this step consider the probable retirement or replacement of every piece of critical equipment. This means production needs must be projected into future years. Where the anticipated usage of a piece of equipment is only for a short period, it may be good judgment and economics to assume the risk of operating without overhaul, depending entirely on the planned inspection periods and routine maintenance.

One of the objectives of a planned overhaul program is to maintain the average age of the windings of all electrical equipment at a predetermined number of years. This helps prevent a situation where you may wake up to the fact that nearly all your critical machines are operating on borrowed time. Usually where a planned overhaul is being carried out, consider reconditioning of dependent or secondary equipment at the same time. Think of overhauls by manufacturing process rather than by machine.

What a workable electrical maintenance scheme means to you. There is a steady movement today throughout industry toward increased mechanization. In increasing numbers, operations are being controlled automatically. Continuous processes, where a line of individual machines is coordinated to function in tandem as a single machine, are growing. The thinking needed to keep production flowing is being shifted from production worker to maintenance man.

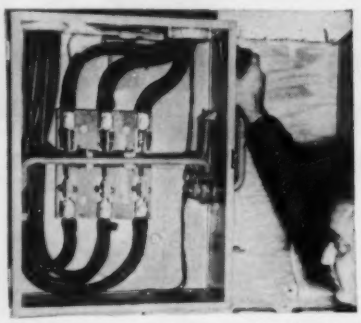
You are the man responsible for upkeep of machines in your plant. It's not a simple job since machines are becoming more complex. It requires more maintenance know-how and specialized skills. Machines are subject to heavier-duty cycles. More and more the responsibility for increased production rests on your shoulders. By installing a really practical electrical maintenance program, and checking it regularly, you will meet that growing responsibility.

1 REFRIGERATION Hook suction and discharge gages to refrigeration compressor. Suction valve is cracked open—as in normal running position

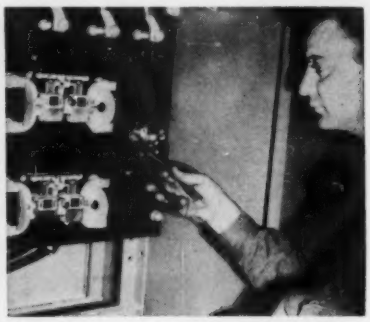


2 Close main liquid-shutoff valve at condenser-receiver outlet. Steps one and two are performed with the refrigeration compressor in operation. Make sure valve is seated

6 Close discharge valve on refrigeration compressor. Disconnect the suction and discharge pressure gages

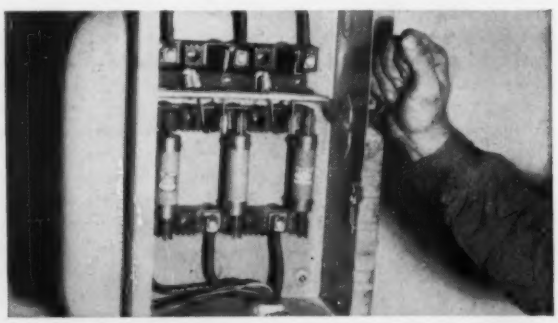


7 Swinging over now to the electrical portion of the refrigeration system, throw main switch to off position



8 To complete the electrical shutdown of refrigeration units: Remove thermal overload heaters from starter panel

12 COOLING TOWER First step in correct shutdown of cooling-tower system: Inspect ball float and close makeup-water shutoff valve at tower sump



13 To shut off power, throw main switch, delivering electricity at cooling-tower-pump motor, to off position. Don't rely on shutting off power by operating motor's pushbutton

Take these steps now...

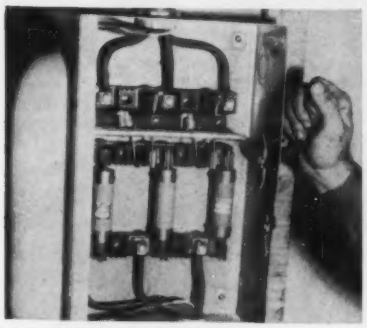
for trouble-free air conditioning... next summer

When The Thermodyne Corp's service dept takes an air-conditioning unit out of service for the winter they follow this careful procedure

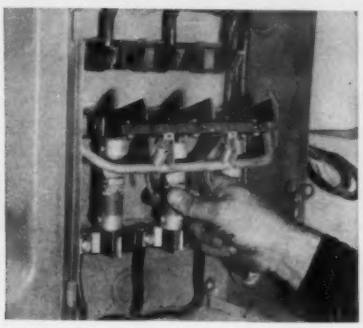
3 Operate compressor until suction gage reads zero psi. Repeat until gage remains at zero. Then shut off machine

4 Close hot-gas-inlet valve to condenser-receiver, locking in all the refrigerant. This completes pumpdown

5 Shut off the refrigeration-compressor suction valve. Care in performing this step will avoid burrs on valve stem

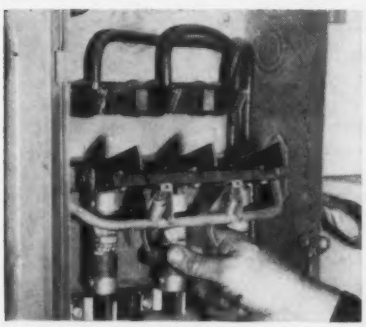


9 CHILLED WATER Throw main switch delivering power, at chilled-water pump, to *off*



10 Make sure the chilled-water pump motor isn't accidentally turned on: Remove all fuses from the switch box

11 Drain the chilled-water pump and piping system when there is possibility of freeze up during off season



14 To insure against startup of pump by unauthorized personnel, remove fuses from the pump-motor switch box

15 Drain and clean the cooling-tower sump. Also, drain the cooling-tower pumps and makeup-water piping

16 Remove cooling-tower cover plate. Inspect, and clean any dirt and chemical deposits from spray nozzles

17 CONDITIONED AIR Next, drain chilled water cooling coils at all air-handling units

18 Remove the strainer plug. Inspect and clean chilled-water strainer at inlets to all coils. Install clean strainer

19 Remove and inspect air filters. Follow the manufacturer's instructions for cleaning. Replace if necessary

LIVONIA FIRE started when welding spark hit drip pan, might have been prevented by following established safety precautions

There were 35,700 industrial fires last year. Many could have been prevented by finding and removing the causes before the fire. Based on National Board of Fire Underwriters' recommendations, here are . . .

28 tested ways to prevent fire

1 Keep all parts of the plant clean and in good order. Prevent crowding of machines, materials and shipments.

2 Do not allow excess packing materials and empty boxes to accumulate in shipping and receiving rooms.

3 If excelsior, straw, paper or other combustibles are used for packing, keep only a day's supply on hand, in a metal-lined box. Provide counterweighted cover with a fusible link to insure automatic closing in case of fire.

4 Use approved waste cans with self-closing hinged covers as receptacles for oily or soiled waste, rags, excelsior or anything used to rub down oil finishes. Remove such waste from building daily, or burn at once.

5 Keep stocks of combustible materials used in manufacturing processes in piles as small as possible. Don't pile any stock high enough to interfere with operation of sprinklers.

6 Lay out production lines so fire in one area will not shut down the whole plant.

7 Never let refuse, waste papers, old lumber, empty cans, drums and barrels pile up near buildings.

8 Leave at least 20 ft between exterior building walls and the outside storage of wooden boxes, packing cases, crates, pallets, skids or lumber.

9 Keep dried grass, weeds and brush cleared away from buildings. A locomotive spark, carelessly discarded cigarette or match may ignite these and burn the building.

10 Provide metal lockers for employes to minimize spread of fire starting from a hot pipe in street-coat pocket or a bunch of waste left in an overalls pocket.

11 Forbid smoking on the premises, except for designated smoking areas. Provide enough ash trays in those areas.

12 Keep plastering and sheathing in good repair so nothing can be thrown into hollow spaces behind.

13 Keep fire doors closed when not actually in use, unless they are automatic-closing type. Be sure they are unobstructed and free to operate at all times.

14 Never permit an open flame in the presence of highly combustible materials or volatile flammable liquids, or where combustible dusts may be present. Use explosion-proof lights

What General Motors is doing to prevent future fires

Since the $35 million fire at their Hydra-Matic Transmission Div in Livonia, Mich. last year, General Motors has tightened up on fire-protection measures in all plants. Here are highlights of new regulations:

Divide huge manufacturing areas with firewalls, so no open area exceeds 250,000 sq ft. Install fire-barrier partitions and draft curtains to segregate hazardous areas. Enclose all vertical openings, such as stairwells and elevator shafts, with firewalls.

Install 100% sprinkler systems in all plants except where water might cause an explosion or seriously damage major electrical equipment. Feed sprinklers from outside underground loops.

Arrange for at least two sources of plant water supply. Secondary source must be able to meet any probable demand. Install standby-powered pumps.

Put in enough yard hydrants, interior standpipes, hose connections and hose so water streams can reach complete interior, exterior, and entire roof of plant.

When possible, put hazardous operations like paint mixing, flammable liquid storage, in separate buildings. Otherwise, locate the operation in an area adjoining an outside wall, and enclosed by a firewall with protected openings. Keep hazardous operations away from cafeterias and toilets.

Construct new roof decks of precast concrete or nonmetallic, noncombustible material where pitch or asphalt is to be used. Use noncombustible insulation materials, and seal all joints. Install roof ventilators to exhaust smoke and heat. Use parapets or fire stops to limit roof areas to about 100,000 sq ft.

Install more fire-fighting equipment, both mobile units and portable first-aid extinguishers. Provide ladders for fire-fighting use only. Retrain all fire brigades.

Where possible, substitute high-flash-point materials for low-flash materials. If this is impossible, isolate the operation.

Insist that outside contractors as well as regular employes follow safety regulations. Keep contractors' temporary buildings at least 50 ft from building under construction, with no storage or parking between. Remove all combustible debris every day; remove noncombustible debris at least once a week. Use fire-resistant tarpaulins during construction. Employ a special man for the sole purpose of fighting fire during cutting or welding operations.

Build roadways completely around plants under construction, so mobile fire-fighting units can reach any section of the plant.

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and switches near flammable vapors or dusts. If lights are subject to mechanical injury, enclose in wire guards.

15 Make sure boiler room is free from accumulations of combustible refuse. Never place any combustible material on boilers, ovens, flues or smoke pipes to dry.

16 Where steam pipes pass through or close to woodwork, see that there is a clear space between the two. Prevent lint and light combustibles from accumulating.

Conditions are unsafe if you cannot hold the back of your hand to the woodwork without discomfort. Do not attempt to remedy this by covering woodwork with metal, as metal transmits heat and hides any subsequent charring. If you need a protective covering, use sheet asbestos and metal, with an air gap between the wood and the insulation.

17 Keep soft-coal piles away from wooden structures, and don't pile coal too high. Provide good ventilation for coal storage to prevent accumulation of gases.

Oil or liquefied petroleum gas used as fuel should be stored as advised by Fire Underwriters' standards. Furnace installations should follow these recommendations too.

18 Lubricate machinery regularly with top-quality oil. Follow manufacturers' instructions for oiling, cleaning motors.

19 Install electric wiring for heat, light or power in conformity with National Electrical Code. Don't permit temporary or makeshift wiring, or use extension cords for any permanent installations.

20 Store lime above the flood level of adjacent streams, and protect it from water from other sources. Lime heats if it gets wet; this has caused many fires.

21 Provide special storage for hazardous chemicals—like chlorate of potash or other chlorates, peroxide of sodium, carbon bisulfide, picric acid, ether, acetone, amyl-acetate, phosphorous, benzol, ammonium nitrate, perchloric acid, hydrogen peroxide and hydrazine. Follow recommended safeguards of Fire Underwriters or National Fire Protection Association. Instruct employes in methods of safe handling.

22 Check whether your property is subject to danger from ammunition and other explosive materials in railroad cars, trucks or vessels. Invoke the aid of municipal regulations and transportation company rules to minimize such danger.

23 Avoid use of portable gas heaters with flexible tubing for space heating. Permanent gas-furnace installations are safer and more efficient. Be sure gas appliances are vented.

24 If you smell gas, ventilate the place thoroughly by opening windows and outside doors before trying to find the leak. Get personnel out. See that no open flames are in the vicinity. Prohibit smoking and striking matches. Call gas company or plant maintenance men qualified to find leaks.

25 If you must use matches, be sure they are the safety type.

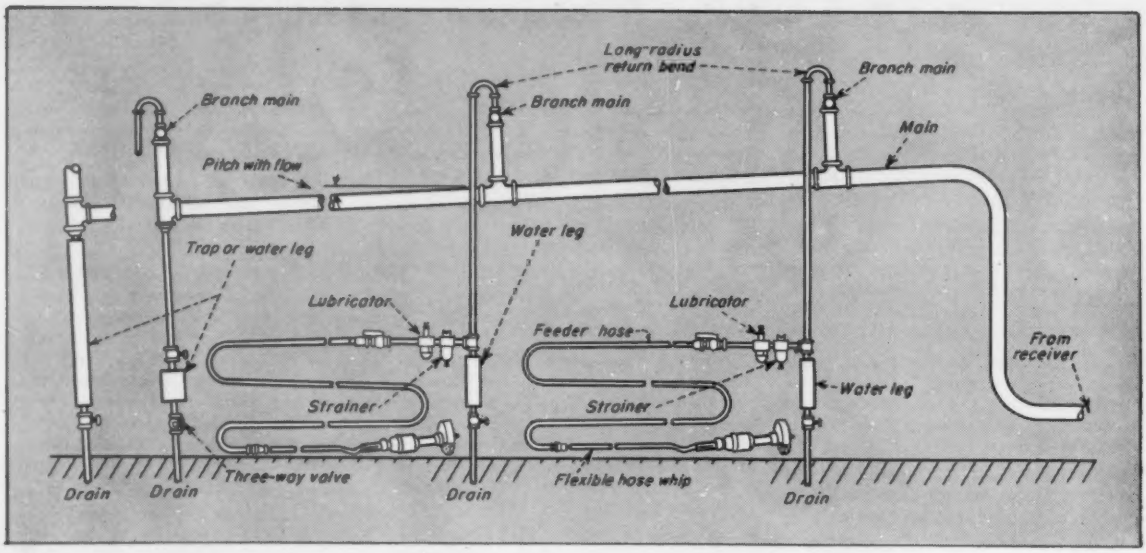
26 Isolate dangerous processes. Hazardous processes or devices that might start a fire should be carefully segregated and properly separated from the rest of plant. Equip hazardous areas with fire-extinguishing or detection equipment.

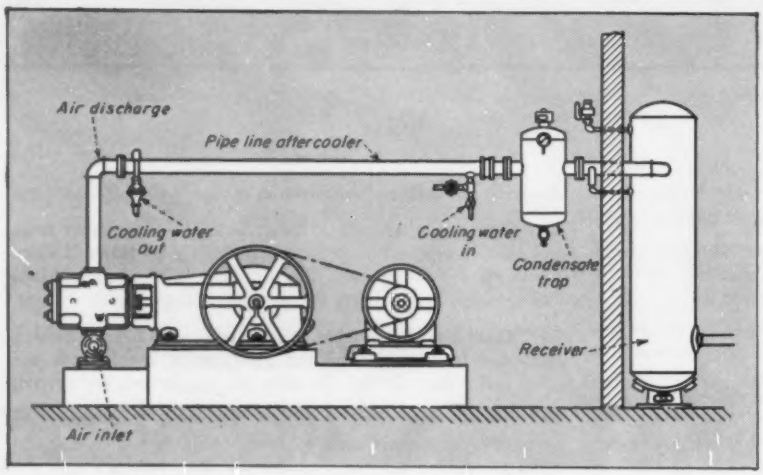
27 Keep flammable liquids in a separate storage room or house. If possible, never keep the main supply of flammable oils and volatile solvents inside the main building. Bring in only enough for immediate needs.

Flammable liquids for cleaning and machinery should be nonexplosive, with a fire hazard no greater than kerosene. Use approved safety cans for the day-to-day supply.

28 Take extra precautions in welding and cutting operations. Be sure permanent installations meet safety standards. When using welding in repair or alteration work, notify the plant fire chief. He should check on safety provisions. Keep sparks and molten metal from dropping on combustible materials by removing combustibles from the work area, or shielding with metal, asbestos or flame-proof canvas.

Inspect all areas near the welding operation after the job is done to see that there are no smoldering fires.





1 Recommended layout for air-piping system. With such a layout, moisture due to abnormal conditions in the piping is kept from reaching air tools

2 Compressor arrangement shows piping to receiver. Moisture condenses in aftercooler and trap collects, removes it. Normally condensation stops here

Protect your air tools from moisture

By E C POWERS, *Educational Director, Compressed Air and Gas Institute*

► DRY AIR does not exist in nature. When we describe air as dry, what we actually mean is relatively dry.

The amount of water vapor that can be present at a given temperature in a given volume is independent of the other gases present. For example, 1000 cubic feet of free air at 70 F and 100% relative humidity contains 1.15 lb of water vapor. If this air is compressed to 100 psig and then cooled to its original temperature, it contains saturated water vapor weighing only 0.15 lb because the volume has been reduced from 1000 to 128 cubic feet. The difference in the weight of water vapor under the two conditions, 1.15—0.15, is one pound, condensed from the air as water.

Suppose we have a compressor delivering 2000-cfm air at 100 psig, with inlet free air at 70 F and 64% relative humidity. Operating under these conditions during an 8-hour day, the compressor passes 710 lb of water vapor. Of this, about 596 lb are deposited as water in different parts of the compressed-air system.

The water washes away the lubrication from any tools or other lubricated devices it reaches, causing excessive wear and maintenance. Water in compressed air also causes water hammer in pipelines and reduces their carrying capacity by collecting at low points. In cold weather, the water may freeze

and cause bursting of the air piping.

Fig. 2 shows equipment designed to prevent the greater percentage of water from reaching the lines. As an example of what the system will do, suppose the compressor is delivering 450 cfm free air at 100 psig, with inlet air at 80 F, 70% relative humidity. The 27,000 cu ft per hr of inlet air carries 29.67 lb (3.56 gal) per hr water vapor. Air temperature goes up to 360 F because of compression, while the amount of water vapor remains the same. Air is cooled to 80 F in the aftercooler, causing 2.88 gal per hr of water vapor to be condensed. Discharge air now contains only 5.67 lb (0.68 gal) per hr water vapor. So only 19% of the original water vapor remains in the air to pass into the receiver, pipelines and tools. As air temperature is normally below pipeline temperature, there is practically no further condensation.

Normal conditions stated above can be upset, however. The cooling water to the aftercooler may not be cool enough to bring the compressed-air temperature down to desired limits. Or temperature extremes in the plant may result in heat loss from the pipelines. Both can cause additional condensation from the compressed air.

Piping should be arranged to take care of this additional condensation. Fig. 1 shows a recommended air-piping system. The most important elements of this system are: sloping main lines or header; liberal use of drops, traps and screens; outlets at top of header.

Sloping the mains in flow direction permits both flow and gravity to carry condensed vapor to traps or drains placed at frequent intervals. Without the proper slope, water accumulates in the line causing corrosion and buildup of restrictions, and thus reducing carrying capacity. This may result in pressure losses and decreased tool output.

Adequate use of traps, drops and screens, see Fig. 1, keeps moisture and dirt from the tools and makes it unnecessary to waste time and air in the morning to clear lines of water. Traps should be emptied regularly and never allowed to become full and thereby inoperative.

Automatic traps ease the operator's job. Discharge can be either continuous or intermittent. But a great deal of air may be lost through continuous discharge. And condensation is not as rapid as in steam lines. For these reasons, the intermittent discharge is best for compressed air.

When air has only small amounts of moisture, the trap may need periodic priming to prevent air from blowing through. Conditions may require that a long pipe, with insufficient slope for good gravity drainage, be used between the trap and the equipment it drains. For such an arrangement, water may not be able to reach the trap because air is pocketed in the trap body. The trap body should be suitably vented to take care of this.

Traps discharging into sewers waste air when not in good working order. In such cases, drains equipped with 3-way stopcocks provide quick and positive means of inspection.

Down pipes or hose should never come directly off the bottom of air mains. Connections should be made at the top of the main, and long-radius return bends used. This prevents water carryover to the tools.

Rent an air-conditioning system for your building... and save

There has been a recent upswing in rental plans for heavy machinery. Construction and business machines have been available for some time, and in the last few years air compressors and machine tools have been added. Of current interest in the field is a rental plan for air-conditioning systems offered by the Broadway Maintenance Corp of Long Island City, New York. Plan includes maintenance of system.

Suppose you are interested in buying a $100,000 air-conditioning system. Because of taxes, this would mean that your firm must earn at least $166,000 to cover the air-conditioning investment. With the rental plan mentioned above, you can have the same system installed and maintained for $40,000 a year for a 5-year period. And the amount is charged off as an operating cost. Plan permits ownership.

One industrial plant was making products under government contract and getting 60% rejects because of corrosion by sea-coast air and dust. Government approval for a capital expenditure would have taken months, with large financial losses during the delay. The rental plan solved the problem, and cost of air-conditioning system is paid as operating expense.

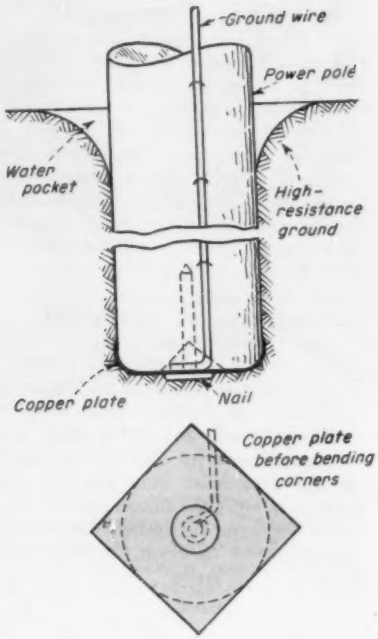
5-TON PACKAGED UNIT. Rental contract covers installation and maintenance of system for a fixed charge over a 5-year period. At end of this period, the customer has option of continuing rental plan at reduced rate or of taking title to the air-conditioning installation. Most choose to extend the rental arrangement

Timely PRACTICAL IDEAS *that will help you do a*

Mirrors save operators from neck craning

KEEPING AN EYE on those high boiler gage glasses is no problem in this plant. Two mirrors on each boiler are at just the right angle to show the water level without looking up. There are many ways to attach mirrors. The one shown is very sturdy. Boiler operators polish the glass with wiping paper so water level is clearly visible at all times.

Courtesy, Philadelphia Electric Co.



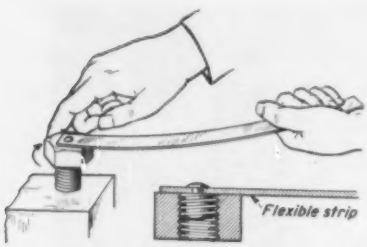
Lightning protection for long power lines

BECAUSE 3-PHASE transmission lines in industrial plants are sometimes several miles long, protecting them against lightning may be a tough problem.

One large project was in an area frequently struck by lightning. First, a single 3-phase line at 2400-v failed. We had over 60 outages in three months from lightning.

For better protection, we placed a wooden bayonet 4½ ft above each pole. We then strung a ground wire on top to bring the phase wires within the 30-deg protection angle. Overhead ground-wire was earth grounded at each pole to a low-resistance ground. A low-resistance ground is important: Suppose that ground wire down the pole's side should end in a common driven ground. Also, that resistance to ground is 20 ohms and that lightning struck overhead ground-wire near pole. Current flow of 50,000 amp is common for a flash. That much current flows in about 20% of flashes in some areas.

Let's see what voltage you must have on ground wire to make 50,000 amp pass to ground. Ohm's law $E = IR$ gives answer. I is 50,000 amp and R is 20 ohms, so voltage on ground wire leading down pole will be 1,000,000 volts. That would be dangerous for anyone near pole. Taking striking distance from



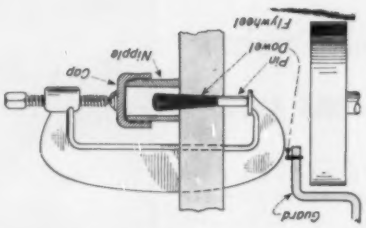
Starter for machine nut

HERE'S A TOOL to help start nuts on threads in those hard-to-reach locations. And it can be used for various-sized nuts. Using only one finger of one hand to start nut saves fumbling, losing it.

To make tool, use a thin flexible strip of steel for handle. Weld or rivet a short piece of loose-fitting male thread near one end. Thread is same as nut it's to be used for and should go half depth into nut.

To use, first screw nut onto short thread. Then hold handle in one hand and extend tool into restricted area to place nut in position. Held in place, one finger of other hand reaches in to turn nut and start it on thread. Flexibility and varied length of handle allow many positions for this tool.

H NYE JOSLEYN *Fort Dodge, Iowa*



Removing dowel pin

PROBLEM WAS TO REMOVE a locating dowel from diesel-engine flywheel housing. Replacement engine had no dowels and all lathes on station were used so we couldn't make another dowel. One dowel presented no problem. It could be driven out with a drift punch and hammer by removing the starter-mounting hole cover. The other dowel was located in flywheel housing in such a position that there was no opening opposite it. Clearance between housing and flywheel was slightly over an inch.

I placed a pipe nipple with cap against guard over the protruding dowel, *sketch*. A half-inch pin, between end of dowel to be removed and "C" clamp, did the trick. Stubborn locating-dowel finally dropped into the pipe nipple.

W P KEEL *USS Taconic*

a sharp point at 1 in. for each 10,000 volts, anyone within 9 ft of pole would be exposed to sudden death.

Ground-resistance test of several ground rods with a ground-testing megger showed resistances up to 1000 ohms. Grounds of a few hundred ohms were common. So we established desired ground-resistance at 5 ohms—would not tolerate anything above 10 ohms.

Best ground for new lines in this terrain was a copper plate nailed to pole's bottom just before pole was set, with ground-wire bolted to it, *sketch*. To help keep ground moist around plate, a cup depression was made where pole entered ground. This made a basin for rain water to collect and leak down along ground wire to pole's bottom, tending to keep soil moist under plate for low ground resistance. Another advantage of plate at pole's bottom was it couldn't fail to make good contact with earth. Reason is weight of pole and equipment always presses down.

When resistance tested greater than ten ohms, underground leads were taken from ground wire in radial directions for about 25 ft where extra ground rods were driven. Thus 10-ohm grounds were maintained in all places except where volcanic-ash ground offered too high a resistance. In these places, we installed a buried ground wire and connected to several ground wires near poles, to drain current to low moist areas where resistance was within desired limit.

All grounds were checked at regular intervals to be sure no ground wires had loosened or broken, or that ground resistance had become too high. High resistances discovered were corrected to keep within specified limits.

Results are excellent and outages due to lightning are almost eliminated.

G P PEARCE
Albuquerque, New Mex.

Chromate coatings

ZINC COATINGS protect iron and steel from weather, but they tarnish and retain unsightly finger marks. Then paint peels from zinc-coated surfaces.

Chromate treatments now eliminate those disadvantages. Thin chromate conversion coatings may be colored or clear and may be bleached off to give a surface for nickel or chrome plating.

These new protective films already have a variety of applications, from welding tips to religious ornaments.

Courtesy, Allied Research Products, Inc, Baltimore, Md.

What would you have done?

AS SUPERINTENDENT of an apartment house many years ago, my phone rang at 6 am one cold Sunday morning. "I'll sue the landlord—my baby's frozen stiff—wacha mean shutting off the heat on the coldest night of the year?" My wife answered the phone while I checked the oil burner in the boiler room.

I found the burner wasn't getting oil. Cleaning the filter and pump strainers did no good, nor did a check on the oil valve. Yet a vacuum and pressure gage showed oil pump to be OK.

By this time, I had for company several tenants clad in heavy overcoats. Those without phones or too lazy to come down banged on risers.

I began to disconnect the suction line and attach it to pump discharge. Then I jammed the controls and started burner, intending to blow the line clear. But 150 psi failed to move the obstruction. I wondered if suction line had a check or foot valve inside the tank.

What to do now? It was 8 am and outside temperature was 8 F—and everyone giving me trouble. Maybe I could get in touch with the oil company and have them deliver a few drums while I broke the concrete over the oil tank and found the trouble. Maybe a couple rolls of copper tubing as a temporary line but where to get the tubing Sunday?

Suddenly I remembered a large roll of new 1-in. hose, which was for emergency use in case of fire. But this *was* an emergency. I connected hose to pump's suction, then ran it along boiler-room floor, out through a window and down the tank's fill-pipe. In a matter of minutes, everything was under control. Next day I found the internal suction pipe did have a foot valve, which prevented blowing the line back. A large piece of waste had plugged the suction. What would *you* have done?

ART CANNON
Laurence Harbor, N. J.

Here's what we would have done

TO TELL ac from dc (POWER, July 1954, page 129).

G P Pearce could avoid spots before his eyes by using a neon lamp with same test socket. Place each lead across two wires, put one needle clamp on wires and hold other needle clamp—lamp lights on ac feed.

F J ARDOLINO *Brooklyn, N. Y.*

Simple vibrating voltage-tester is best. If I had no tester with me, I would have picked it up when returning for wire that was used for temporary feeder to magnet. Place leads of tester on pair of chosen wires and get answer at once. Voltage of ac vibrates tester—no vibration with dc. You can feel vibration when holding tester, known as "wiggie."

B A CROSSON *Cranston, R. I.*

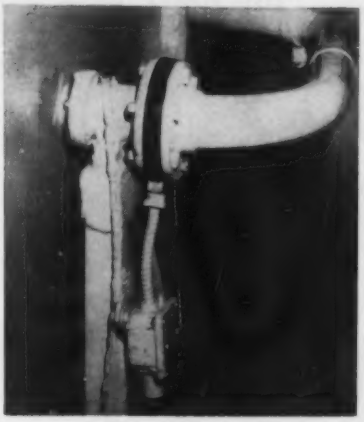
Buy small neon-glow test lamp in auto or radio store for 40 cents, carry in tool box. It not only tells ac from dc, but also indicates polarity on dc. If both electrode plates glow when lamp is across line, current is ac. If one plate glows, line is dc; side connected to glowing plate, negative. Lamp with test prods is fountain-pen size, good to 500 v.

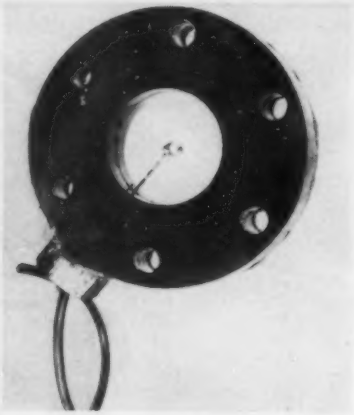
W ASCHENBRAND JR. *Wales, Pa.*

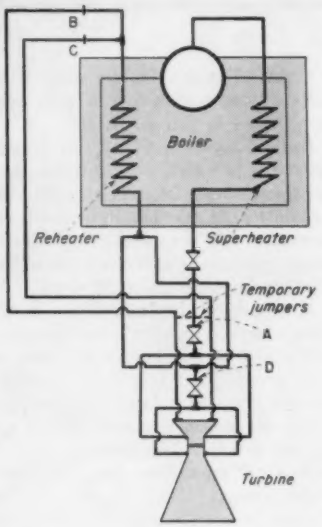
(*Continued on page* 138)

More PRACTICAL IDEAS

Begins on page 136







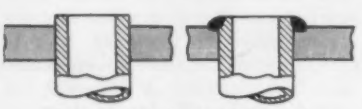
This gasket for gasoline hose is new idea

SPECIAL SYNTHETIC rubber gasket for gasoline hose reel on aircraft carriers might find some applications in industry. It withstands greater pressure, gives better seal than older plastic type.

Gasket is used for high-capacity gasoline systems having electronic control wire for safe operation. This wire is run through interior of hose and hose reel from a switch housing at nozzle end to outlet on hose reel. Wire comes out of fluid path at gasket and is insulated from hose reel to prevent grounding.

Made of fabric-reinforced-neoprene rubber sheeting that forms an outer ring to withstand compression, gasket has 22 layers. Inner ring is butadiene acrylonitrile rubber for solvent resistance to gasoline. Spring is monel wire.

Courtesy, "Buships Journal," USN.



Tube projects beyond tube sheet

Tube recessed into tube sheet

Single-bevel-groove joint

Stamped metal joint for braze joint

Did you know . . .

THAT THERE ARE many ways to weld and braze tubes to tube sheets of unfired heat-transfer equipment? For complete details, not covered in these sketches, read ASME paper No. 53-A-175, by H A Huff, Jr, and A N Kugler.

Let the weather remove mill scale

AGE-OLD METHOD of removing mill scale is exposure to weather. Before painting outdoor structures, mill scale should be removed or scale will chip off, taking expensive paint with it.

Scale removal by weathering ranges from removing only mill scale that's already loose to completely eliminating tight scale. Extent of weathering depends on coating to be applied and service metal is used for.

Time needed to descale metal completely in this way varies from 30 days in severe and humid industrial areas to several years in milder places.

If metal weathers and descales in a low-humidity atmosphere, the loss is slightly higher than with a surface prepared by blasting. In corrosive atmosphere or one of high humidity, losses caused by removing mill scale can cost three times that for losses from blasting. In these environments, weathering may cause pitting. Once such pits are formed, metal cannot be economically restored to its original value.

Courtesy, National Association of Corrosion Engineers

Blowing out the main steam lines

SKETCH SHOWS method we used for blowing new main steam lines of a 100,000-kw generator and a 750,000-lb-per-hr boiler having reheat cycle. Purpose of blowing was to get rid of welding beads and other foreign particles that might give us trouble.

First we placed 6-in.-diameter temporary connections to feed steam into the reheat lines. These jumpers fed steam to reheat lines without going to turbine. After the main line was blown at the stop valve *A*, the two reheat lines were blown ahead of reheater at *B, C.*

Then we coupled the reheat lines and blew them again, this time through the reheater and out at intercept valve, *D.*

N T PEF *Boston, Mass.*

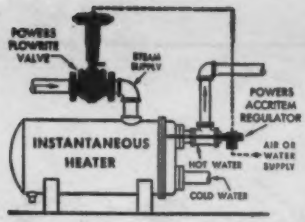
Wow! What a leak detector!

YOU CAN NOW DETECT a leak so small it would take a year to form a single drop. In handling radioactive materials, it's essential that joints in atomic-energy applications be absolutely leak-proof. However, previous hydrostatic tests fell short in finding leakage in equipment being tested.

In new method, vessel being tested is filled with helium, an inert and harmless gas. Then, with a mass spectrometer leak-detector, amount of helium escaping into surrounding atmosphere is measured. In this way, you detect presence of one part of helium in 200,000 parts of air.

Research Center, Babcock & Wilcox

(Continued on page 140)



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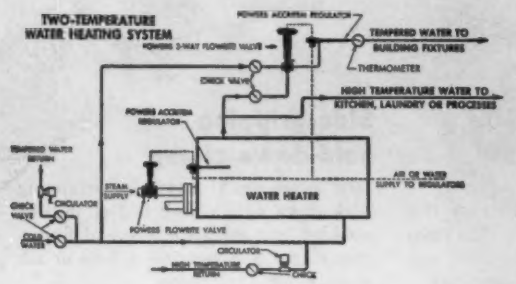

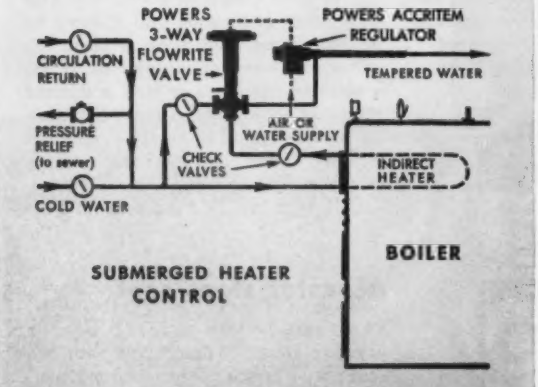

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Use Accritem Regulators to control diaphragm operated valves or dampers. They save labor, stop losses caused by over-heating and have the following—

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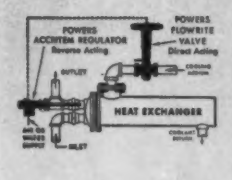
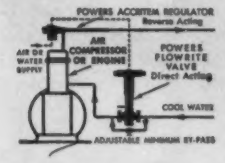
- ***Easy to Install*** Requires 15 lb. supply of compressed air or water for its operation.
- ***Small Size***—regulator head is only 2⅞" x 3⅝", sensitive bulb is 12" long with ½" I.P.S. connection.





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controlled by a POWERS
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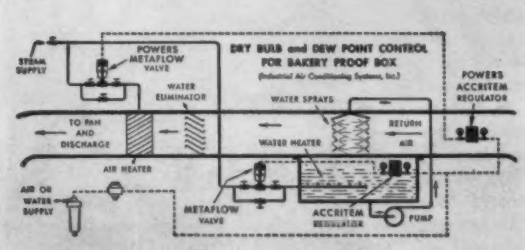

(AMCH)

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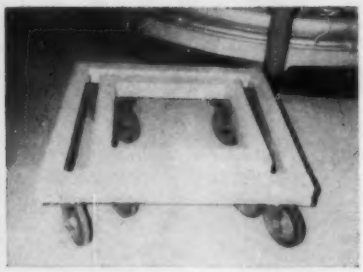
More PRACTICAL IDEAS

Begins on page 136



Wooden dollies handle heavy load now

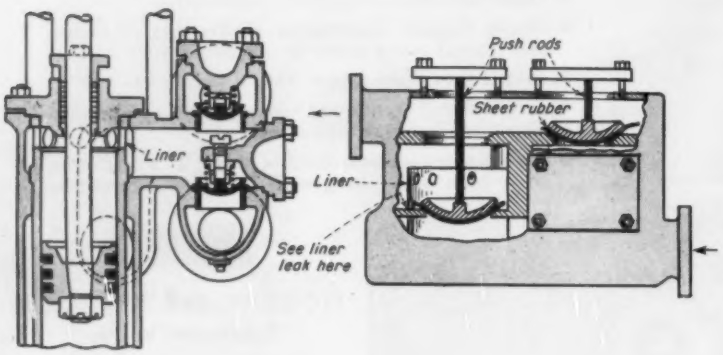
WE HAVE TWO DOLLIES for handling engine parts during overhauls. It so happens that we need only two dollies but we built them of sizes for nesting.

Storing them is space saver in a plant using various-sized dollies. They are economical to build, made of 4x4's and casters, put together with carriage bolts.

When building dollies, remember that larger wheels roll easier. They may cost a little more, but quick and safe handling of heavy parts is important.

Second photo shows strength and stability of these dollies. One man can easily roll the heavy cylinder head.

D L COCHRANE *Cambridge, Minn.*



Here's your 'trick' of the month

YOU CAN EASILY DECIDE if capacity loss in liquid end of vertical feed pump shown is due to valves, plunger packing or leak between liner and pump barrel. Even if you don't have this type of pump, you may use same idea for checking other reciprocating equipment.

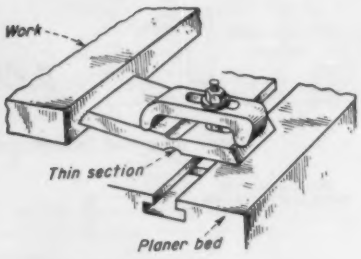
First, remove cover plate on upper end of suction valve, sketch. Then you can see through to top of liner. Blank upper suction and lower discharge-valve with rubber sheet as shown. Then you can check for leak in plunger packing, between liner and pump barrel.

While watching top of liner through the upper suction-valve space, have someone crack the suction valve from deaerating heater. On our ship this heater is 50 feet above the pump. If the plunger needs repacking badly, water will come cascading out of the liner's upper ports. If there is a leak between the liner and the pump barrel, that's also easily seen. Caution! Be ready to jump out of the way and don't open the suction valve too much.

It does take 15 minutes to fashion the pushrods, but you can use them for each check. It takes half an hour to inspect plunger, liners and four valves.

Using this method, I detected four bad liners to the everlasting amazement of maritime inspectors who claimed we hadn't packed the plunger since "way back." But this check convinced them.

R A Foss *SS Sea Leader*



Side-gripping hold-down clamp

THIS HOLD-DOWN CLAMP for strapping work down onto planer bed or milling machine, etc, takes the place of finger-type clamp that requires a hole or rib in work for application.

Two-piece clamp in sketch will grip work piece at its side, pull it down on bed of planer, and allow a clear top surface for travel of cutting tool. It has a serrated front end or face, a thinned center as shown, and a top 2-heel slotted strap. Sets of these are handy and well worth any shop mechanic's efforts to make them.

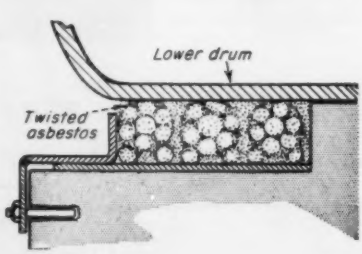
C H WILLEY *Penacook, N. H.*

Asbestos stops soot

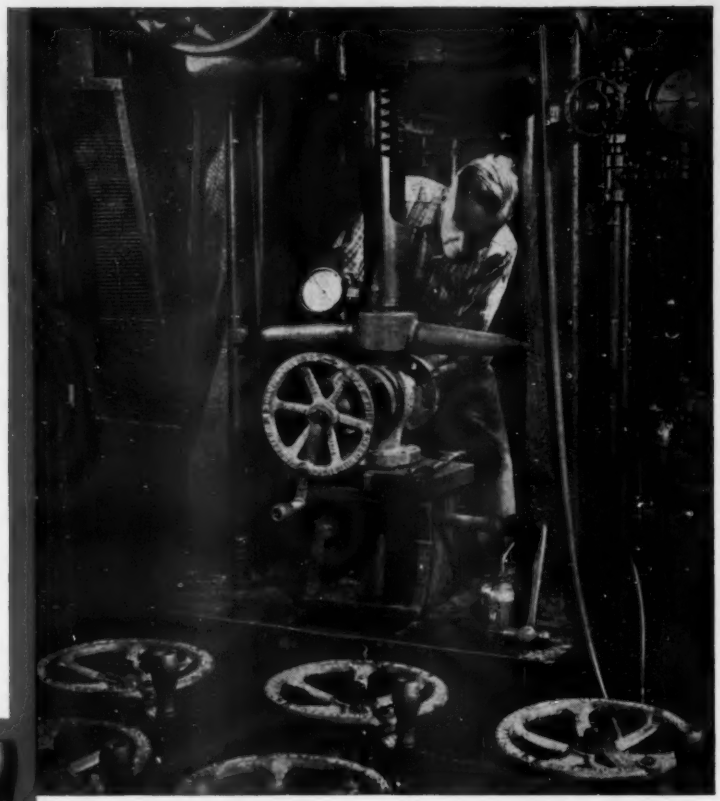
OUR THREE BOILERS of 55,000-lb-per-hr capacity are the 3-dump type with two lower mud drums. When blowing soot, it always leaked outside to boiler room.

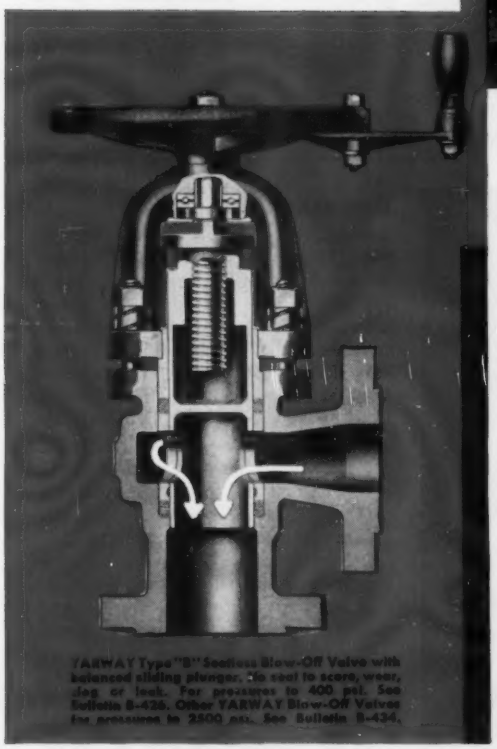
Boiler walls were dirty, and combustion wasn't very efficient because of cold-air leakage into the boiler furnace. We operate the furnace with a slight negative pressure—0.05 in. H_2O.

We tried several kinds of seals around drums but we still had soot. Finally, we tried twisted asbestos rope, sketch. That solved our problem. Now, packing ring at end of drum is tightened periodically, and the outside of boiler is always clean. Combustion is about perfect also, which gives us top efficiency in our boiler performance, thus saves money.



J R BROWN *Bauta, Cuba*





YARWAY Type "S" Seatless Blow-Off Valve with balanced sliding plunger. No seat to score, wear, jog or leak. For pressures to 400 psi. See Bulletin B-426. Other YARWAY Blow-Off Valves for pressures to 2500 psi. See Bulletin B-434.

THIS PRODUCTION "DOUBLE CHECK" SAFEGUARDS YOUR BOILER INVESTMENT!

■ Yes, here is one extra production step we will never bypass! It is your guarantee of a *dependable*, long-life blow-off valve.

In this corner of the YARWAY Testing Department, *every Yarway Blow-Off Valve* is hydrostatically tested at 1½ times its rated maximum working pressure—proved drop-tight for service far beyond normal expectancy.

Not only blow-off valves, but *all* YARWAY equipment undergoes rigorous tests before leaving the YARWAY plant. Why? For one reason—to assure longer and better service in *your* plant. Over 15,000 boiler plants are using YARWAY Blow-Off Valves—some for twenty-thirty years, or longer.

Whenever you are in need of boiler blow-off valves, be sure to *make Yarway your way.*

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
REMOTE LIQUID LEVEL INDICATORS
EXPANSION JOINTS
DIGESTER VALVES
STEAM TRAPS
STRAINERS
SPRAY NOZZLES

PLANT PROBLEMS . . . *helpful info from readers*

How can we protect boiler furnaces?

HERE ARE THE FACTS: We're planning a boiler installation in which gas-fired units will burn about one million cu ft of gas per hr. In addition, each boiler will also burn pulverized coal, either alone or in combination with the gas.

What automatic, semi-automatic or flame-failure devices are needed in these units to prevent furnace explosions from (1) flame failure (2) lighting off (3) switch-over from gas to coal, or the reverse? Will maintenance and inspection increase?

—EK, July Power

Here are the answers

PHOTO SHOWS one of our dual gas-oil boilers, set up for gas firing. We use flame rods and find they are tops. Changeable photoelectric eye provides supervisory flame control for oil or pulverized coal.

The two gate valves on the lower gas burner are a neat idea for better starting of a fire. When putting burner into operation we crack one valve, leaving it that way until we have a flame. For safety, the gas-control valves have a 15- to 20-second delay before they open wide. Cracking the gate valve eliminates sudden ignition, which might upset combustion. Once burner is lit, both valves on lower burner are opened wide.

These gate valves are also handy during light loads because they allow you to vary gas flow over wide ranges without reducing the protection provided by automatic controls.

Large quick-opening valve on upper burner is opened and lit with the igniter cable, which can be swung from either burner, as desired.

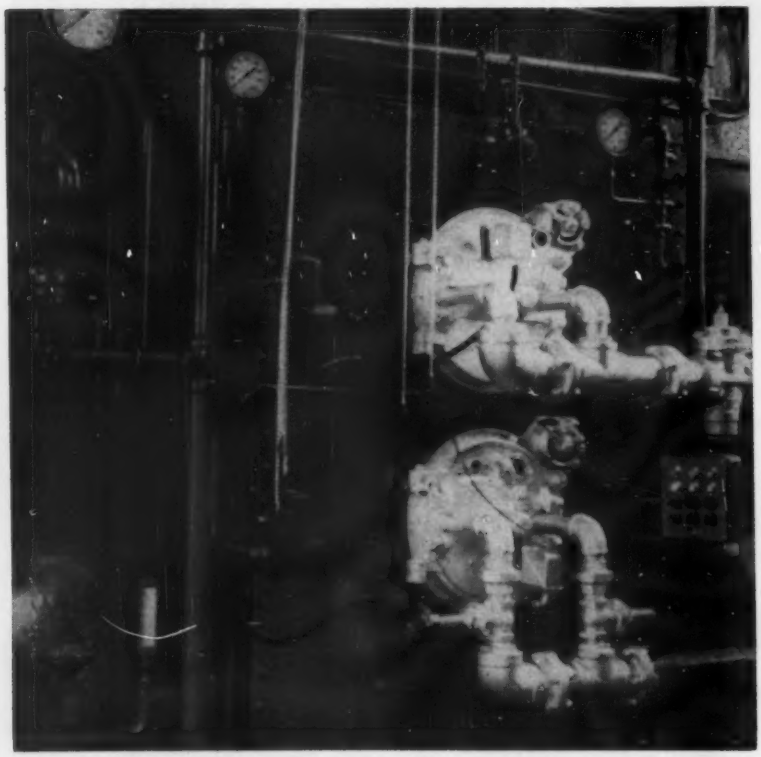
Our insurance company gives a safety-control allowance. More important is the fact that these controls keep our plant safe, eliminating accident downtime.

Control maintenance is simple if you use the instruction manual provided by the manufacturer. It shows the points to check with an ohmmeter and milliammeter. With our valve setup, we simulate the gas flame with a blow torch. Use a flashlight to simulate coal flame.

New furnace controls are so foolproof that outside of routine annual tube replacement, maintenance is practically nil. Buy a good control, remembering to check with newer plants in your area. Operators of these plants know their controls and may offer valuable tips.

L W FITZPATRICK

Jefferson City, Mo.



PROTECTIVE DEVICES for gas-oil-fired boiler use flame rods, starting valves

FOUR BASIC TYPES of flame-failure safeguards are available today: thermal stack switches, photoelectric cells, flame rods and lead sulfide cells. Last type is the latest and is the only single system usable on the flame of any fuel, or on multiburner boilers. In addition, it is the only system that can differentiate live flames from other light or heat sources. It supervises and monitors both the igniters and main burners, affording complete protection through every phase of lighting off and firing. Photoelectric-cell and flame-rod systems are not suitable for large multiburner boilers.

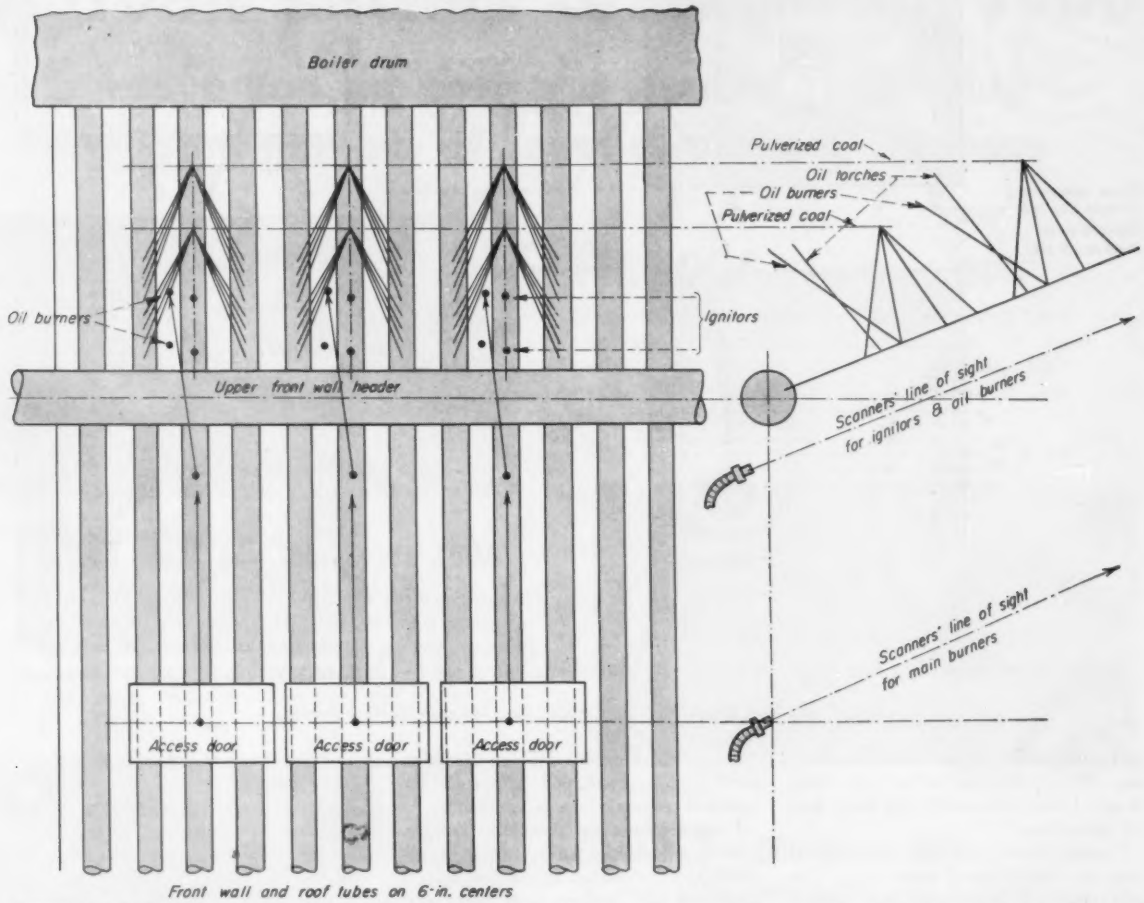
Lead-sulfide cell is actuated by infrared, instead of visible light. When the rays bombard cell surface a drop in resistance of the semiconductor occurs, and a minute current flow takes place. Amplified about 500 times, it actuates the relays in the system.

Since infrared exists in all light and heat, the cell by itself is unable to differentiate between live-flame and other infrared sources. But since infrared emanation exists in various modulation ranges, the control circuitry is designed to filter out every modulation except that of live flame. This is about 12 cps for any fuel burned. So this equipment will "hold in" only on live flame.

Once suitable equipment is available

on furnace protection and coil freezes

TYLER HICKS, *Associate Editor*



GENERAL LOCATION and line of sight for scanners used in a roof-fired watertube boiler designed to burn oil or pulverized coal

for seeing only live flame, but one problem exists—how to apply it so each scanner and its control sees only the flame it is assigned to monitor. Though the problem varies from one boiler design to another, it can be solved by suitable planning of the system.

Sketches, above and on p 144, show the line of sight for scanners for a front-fired, roof-fired and for a tangentially fired boiler unit. While there are variations in control setups from one boiler to the next, *EK* should remember that he can have these controls wired to produce any type of operation he desires. For specific application data and details for a given boiler, consult the control manufacturer. He is in the best position to advise you.

Lead-sulfide cells have complete approval of all insurance bodies and should produce lower rates, depending on your business dealings with the insurance company. Equipment cost is nominal and can be justified on the basis of insurance savings, or any one of several others.

As far as increasing maintenance and inspection time, this is definitely not true for well-designed and installed controls. In fact, low maintenance is one strong point in favor of such controls.

JOHN M ENGLISBY, *Mgr Power Dept, Fireye Div, Electronics Corp of America, New York, N. Y.*

MINIMUM-FLOW STOP on boiler gas controller is what *EK* needs to prevent automatic equipment from reducing gas flow below stable needs. Fan interlocks are needed to shut off gas flow if a fan fails. Also, *EK* should fit a low gas-pressure interlock to shut off flow if pressure ahead of controller falls to an unsafe point.

Another valuable aid is a flue-gas analyzer in continuous operation equipped with an alarm to sound when combustibles are detected. It also aids in giving a guide to control of gas-air ratio for best firing economy.

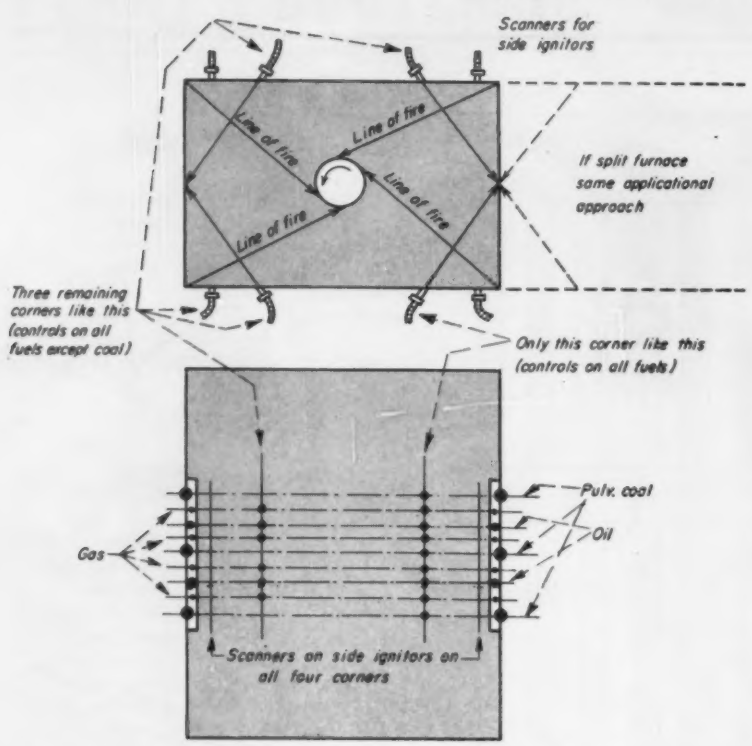
Purge furnace and setting completely before lighting first burner. Before purging, be sure fuel supply for all burners, including pilots, is turned off. This is especially important with gas because it may leak into the setting and be undetected. Vent gas lines.

Use a torch or electric igniter to light off additional burners. Never attempt to light one burner from another.

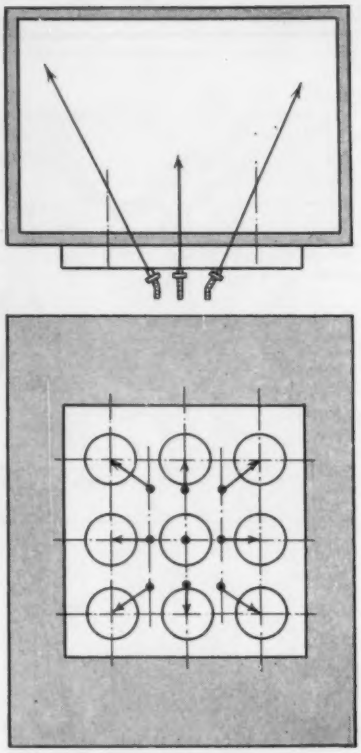
Unless you change from one fuel to another while boiler is operating, you

More PLANT PROBLEMS

Begins on page 142


Scanners for side ignitors
Line of fire
Line of fire
Line of fire
Line of fire
If split furnace same applicational approach
Three remaining corners like this (controls on all fuels except coal)
Only this corner like this (controls on all fuels)
Pulv. coal
Oil
Gas
Scanners on side ignitors on all four corners

FRONT VIEW, tangentially fired boiler, shows scanner location and line of sight



SCANNERS: front, side or rear walls

John M Englisby's letter, "Four basic types," on p 143 explains these sketches

must completely purge furnace and setting. Be sure to keep fuel-air ratio within safe limits when switching fuels during operation.

Control devices certainly are justified from the standpoint of safety only. Use only qualified instrument and control men for maintenance—it always pays in the long run.

ERNEST SHAFER, JR
Carlsbad, N. M.

FAULTY IGNITION most frequently causes furnace explosions. There are three periods during which explosions can occur: lighting off, operation and after shutdown. Light-off explosions are often a result of not purging the unit but poor lighting practice or an inadequate torch are other causes.

Explosions during operation can result from loss of ignition without fuel being cut off, reduction and then restoration of primary air, or accumulation of unburned fuel in furnace. After shutdown, explosions may be caused by unburned fuel or soot-blowing faults.

Good lighting-off practice demands interlocking of i-d and f-d fans. Proper sequence is i-d fan, f-d fan, ignition torch and fuel. Added insurance for sufficient purging is a purge meter.

Good flame-safety protective devices prevent fuel being fed to furnace until combustion chamber is purged of all unburned gas, ignition established and correct lighting-off sequence followed.

During normal operation, flame safeguard must shut off fuel to furnace if flame or power fails or combustion safety equipment becomes inoperative.

Photoelectric-tube flame detectors are popular with pulverized coal; metal electrodes with gas. Vacuum tubes amplify current to operate fuel valves, relays, and other devices.

Maintain sufficient draft during lighting off; use fuel-air ratio recommended by boiler manufacturer. Test fan interlocks regularly. *EK* can't go wrong if he carefully chooses good controls.

A J BREUGELMANS *New York, N. Y.*

FULLY AUTOMATIC control system with furnace television is justifiable in a boiler burning 1 million cu ft of gas per hr. Further protection offered by a flame-failure alarm would also be worthwhile, but it would probably be difficult for the average flame-failure device to cover the required range of flame brightness. Perhaps one of the more elaborate heat-sensitive devices could be used here if desired.

Whole question of control and alarm devices is subject to much argument and is somewhat a matter of the operator's personal preference. One side votes for a supersafe system that shuts them down every time the operator sneezes. The other favors enough controls to shut the plant down while providing alarms indicating the trouble spot so the operator can take corrective steps to keep the unit going.

J L AIKMAN *Nicosia, Cyprus*

DON'T WEIGH safety of flame-failure devices against insurance savings. Use them for safety—that's paramount—take insurance savings as a bonus. Taking another tack, let maintenance and inspection wipe out insurance savings—you still have the safety offered by the flame-failure devices.

EK should steer clear of trying to de-

(*Continued on page* 218)

For readers' advice on coil freezes and for your two new questions, turn to page 146

THESE 3 SUN GREASES WILL DO 95% OF YOUR GREASE LUBRICATION JOBS

—save you the cost and trouble of stocking a large number of "special purpose" greases

FIBROUS • Sun Grease 844X

Has exceptional oxidation stability under high temperature conditions. Recommended for all antifriction bearings. A general-purpose, high melting point lubricant for pressure gun and grease cup application.

BUTTERY • Sun Grease 300A

Especially designed for pressure lubrication of bearings operated at normal speeds and temperatures. Can be used in pressure guns, compression grease cups, or pressure lubrication systems. Has high water resistance and excellent pumpability at low temperatures.

TACKY • Sun Grease 897

For open gears, chains, slides, cams, linkages and bearings. Used whenever "throw-off" must be avoided. High adhesive and cohesive characteristics. An excellent lubricant that is water resistant and does not need frequent application.

Of the 81 different Sun greases, these three can fill the vast majority of your needs. And lubrication simplification like this means worth-while economies for you in several directions. You can reduce the total amount of money you need to "invest" in lubricants. You can greatly lighten the housekeeping job of storing and handling your greases. And you can reduce the confusion and risk of error often created when personnel are required to choose from a large number of greases.

For lubrication points that do require special kinds, Sun offers a total of 78 other greases with a wide range of properties and characteristics.

Find out just how much you can economize by using Sun lubricants. Call in your Sun representative. Or write for information. Dept. P-10.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

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Refiners of famous High-Test Blue Sunoco Gasoline

More PLANT PROBLEMS

Begins on page 142

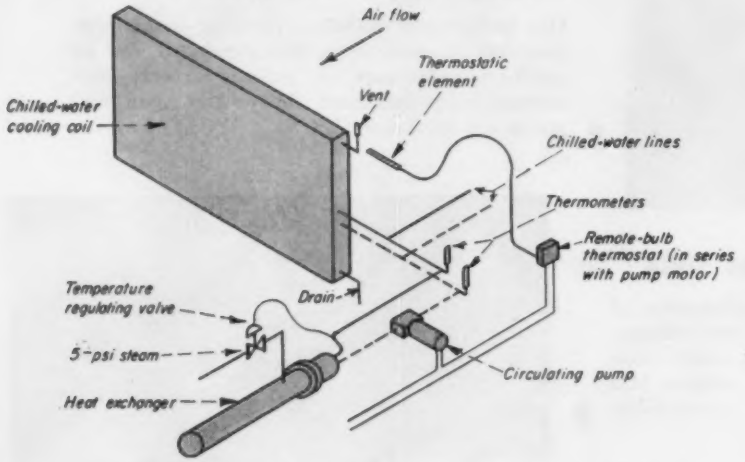
What's best way to stop coil freezes?

HERE ARE THE FACTS: Cooling coils in our air-conditioning system froze twice last year. We wasted $3200 in repair bills because freezes should not occur in well-designed systems.

Both times we drained the coils and blew out remaining water with high-pressure air. But we now think the air passed through the water instead of lifting it.

How can we prevent freezes next winter? We need some air conditioning during the winter months.—*SP, July Power*

Here are the answers



GOOD PROTECTION is obtained with an automatically controlled heat exchanger

SKETCH shows one method *SP* can use to protect his coils against freezing. Thermostat in air stream starts circulating pump when air temperature falls to 40 F. Water being cooled by incoming air opens temperature-regulating valve to admit steam to the heat exchanger. The water is heated to above its freezing temperature by the exchanger, thus preventing ice formation. Exchanger must be large enough to effectively heat the cooling water in the air-conditioning system.

Where a reheat or heating coil is fitted to the inlet side of the cooling coil, a thermostatic valve between heating and cooling coils can be used to insure that temperature of air entering chilled-water coil is 40 F, or higher.

With a heating coil on the downstream side of the chilled-water coil and both fresh-air and return-air dampers, a temperature control set to maintain a minimum of 40 F entering air for the cooling coil prevents freezing.

HAROLD BERSON *Tarrytown, N. Y.*

SEVERAL TUBES in coils for our primary-air supply froze and burst even though coils were drained and one gallon of permanent antifreeze poured through each section.

We were quite fortunate in being able to braze the damaged tubes without removing them from coil headers. Now we circulate a 0-F antifreeze through each of the four coil sections for several minutes before draining for winter. This procedure insures complete mixing of the water and antifreeze.

For additional protection we have a mercury-switch temperature controller to stop fan and shut intake damper when entering air temperature to coil is about 40 F.

A V THEADO *Columbus, Ohio*

WRAP COILS with electric heating cable. Turn juice on during freezing weather. This is a low-cost, effective way of preventing freezeups.

DURWARD C ARCHER *Nashville, Tenn.*

PITCH horizontal coil elements away from the return bends so water will drain by gravity. This may be a costly alteration to an existing job, especially if coil wall is thick.

An alternate scheme uses bosses welded to bottom of coil return bends. A drain pipe or tube is run to bottom of each boss. Each line is fitted with a shutoff valve outside coil housing.

H B WAYNE *Brooklyn, N. Y.*

(*Continued on page 220*)

YOUR OCTOBER PROBLEMS

1 How can we find, put out stockpile fire?

We store between 50,000 and 100,000 tons of coal in an outdoor stockpile served by a radial-type drag scraper having its back post on a semicircular track.

Ever since we started this stockpile two years ago we've been plagued with hot spots and fires. Nothing tried to date has been successful in eliminating the trouble. Though coal losses are not high, it is still a waste to burn it outdoors instead of under our boilers.

What are good ways of finding hot spots and fires? How are fires best put out once they are discovered? Will a change in stockpiling methods help?—*NB*

2 Is sulfur related to ash-fusion temp?

In studying the effect of sulfur on the ash-fusion characteristics of coal I found a definite relation between percentage of total sulfur and ash-fusion temp in several West Virginia coals. Plotting total sulfur percentage against fusion temperature gives nearly a straight line.

Is this linear relation true only for a given seam or area? Or does it hold for other coals? Have *Power* readers who've studied this problem found any constancy between total sulphur content and the three ash-fusion temperatures — initial deformation, softening and fusion temperatures? What are typical curves for various coals?—*FR*

Will you help readers who sent problems? Extra pay for photos, sketches.

BETZ • *A Great Name In Water Conditioning*

Meet your V.I.P.

The Betz Sales Engineer, a *Very Important Person?*

We think so.

With his experience and full knowledge of water conditioning, and with the facilities of the *entire* Betz Organization to assist him, he is ready to step in and recommend ways and means to achieve more efficient, economical plant operation through proper water conditioning.

It's his job to work shoulder to shoulder with you and your operating level personnel . . . assist in setting up correct systems of control . . . keep you fully abreast of the latest developments in Betz water conditioning technique . . . and a host of other services, from "trouble-shooting" to being a real part of your team.

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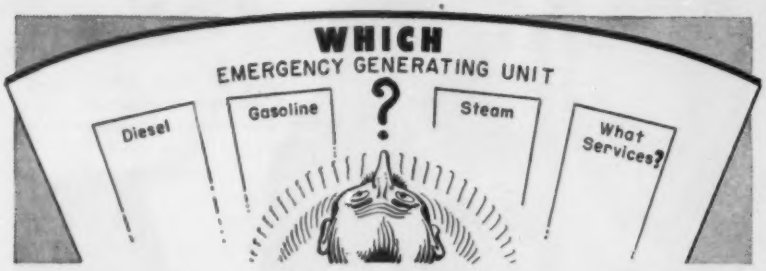
BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ARGUMENTS

Here's the place to unload your gripes to editors, manufacturers and fellow engineers



Diesel plant has many over-all advantages

THE PROBLEM of emergency power in a large industrial plant is so important that Tanasi (p 148, June POWER) should have a competent consulting engineer analyze situation and design plant.

First, consult local underwriters and building and safety officials. Most city regulations provide for emergency power plants, and a properly designed plant may reduce insurance rates.

Emergency unit should be self-contained, have automatic starting and be isolated from the rest of the establishment. This usually rules out a steam engine or turbine, as boiler-room trouble causes loss of steam supply.

A gasoline-engine-driven plant costs less than a diesel, where plant operates only for short periods in emergencies. But local ordinances may penalize gasoline plant enough to offset savings.

Usually the diesel-driven plant has the most over-all advantages. A number of makes of the packaged type are satisfactory for the service.

Emergency unit should preferably be in a building separated from other plant buildings, or else in an isolated compartment, with its own entrance from outside. Keep water in the radiator or cooling system warm so engine starts readily.

There may be some motor-driven equipment in Tanasi's plant that is operated infrequently. By running it from the emergency plant, he may be able to reduce connected load and obtain a reduction in power rates. Besides, running at intervals keeps unit in good condition. In some instances, emergency unit may operate as a peak-load plant.

H T LIVINGSTON *Los Angeles, Calif.*

Cites additional services needing emergency power

IN ANSWER to Tanasi's question (June "Arguments"), the most economical emergency power installation is usually a gasoline- or diesel-engine generator unit. Selection depends on the required

(*Continued on page* 226)

Use gasoline plant for 'emergency only' service

BEST WAY to decide on emergency electric service (June "Arguments") is to make a complete analysis and appraisal, including total present and future requirements, amount of time the emergency service is needed, first cost, fuel cost, interest, salvage value, special personnel required, whether use of emergency equipment may be denied for support and repair of the boilers and power plant.

Gasoline engines pose fuel-storage and exhaust problems, require special consideration as to location. Diesels need heavier foundations, must be heated for starting under adverse conditions.

If unit is used for emergency service only, fuel costs are of little importance.

Considering first cost only, a one- or 2-stage noncondensing turbine-generator may be the cheapest. But cost of auxiliaries, piping and personnel for operation, plus limitations of where unit may be installed, can easily outweigh the initial cost advantage.

When deciding between gasoline and diesel engines, the problem roughly resolves itself into first cost, operating hours, fuel cost and maintenance. In the 10-kw range, gasoline-fueled units are initially cheaper, but after 7000 hr of operation, costs of gasoline and diesel units balance. In the 100-kw range, balance point is about 5000 hr.

Maintenance and repair are greater on the gasoline engine, but conversely can usually be performed more readily and at less cost than on diesel or steam.

Ordinarily, I believe gasoline is more desirable for strictly emergency use.

JAMES SCOTT *Westminster, Md.*

Separate emergency circuits from main load

I THINK Tanasi (June "Arguments") has covered all emergency services required except maybe a fire pump, unless the sprinkling system is adequate for fire service.

(*Continued on page* 226)

Questions cause of wood deterioration

OUR ENGINEERING DEPARTMENT feels that the text of the article, "Right Water Treatment for Cooling-Tower Life," May, p 100, does not conform to the title. The discussion concerning wood deterioration is quite out of date.

The author recognizes only one type of chemical attack, delignification, and completely ignores decay, which has been found to be the principal cause of deterioration of cooling-tower lumber.

HOWARD DEGLER *Kansas City, Mo.*

Use fuel-oil treatment —not fuel oil

IN "Recommends alternate solvents for cleaning" ball bearings, p 136 August POWER, first sentence in the third paragraph should read, "For extremely grimy ball bearings from motors, we use No. 6 fuel-oil *treatment*." The all important word "treatment" was omitted in the item as it ran in August.

L W FITZPATRICK
Jefferson City, Mo.

EDITOR'S NOTE: *We slipped on this one. By all means follow the above recommendation for cleaning bearings.*

Hurrah for the difference!

I READ with delight the difference of opinion on "Boiler tube emergency repair" (July "Arguments"). I think Reader Wayne has probably *never* faced an emergency situation, hence his leisurely recommended procedure.

Will you please ask Marmaduke Surfaceblow, Esq, how he would have fulfilled his bet about the ten pounds of steam to every reader?

CARL BACHMANN *Rego Park, N. Y.*

MARMADUKE'S NOTE: "BILGEWATER on paying off bets! I never lost a bet in my life, and I never will, either."

Backs up Marmaduke on emergency tube repair

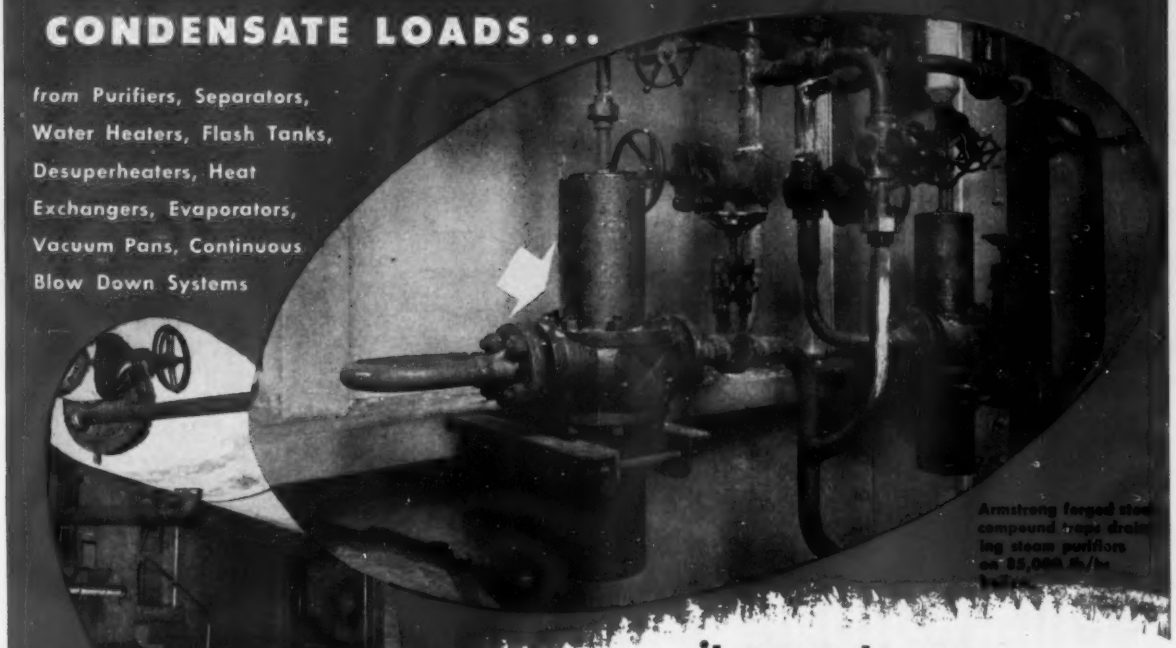
I BACK UP MARMY on the emergency tube repair (p 140, July POWER) and have done exactly what he did. Not often, but a few times, and on crane boilers, locomotive boilers, and the old die-hard wetback Scotch marine boilers.

And I know that hundreds, aye thousands, have done the same thing all over the Western Hemisphere, let alone Africa, and that wee cauld country in the North where economy is essential.

JOHN GORRIE *Euclid, Ohio*

FOR BIG CONDENSATE LOADS...

from Purifiers, Separators, Water Heaters, Flash Tanks, Desuperheaters, Heat Exchangers, Evaporators, Vacuum Pans, Continuous Blow Down Systems



Armstrong forged steel compound traps draining steam purifiers on 85,000 lb/hr boiler

. . . it pays to use ARMSTRONG COMPOUND STEAM TRAPS!

Because:

1. **They provide automatic drainage of condensate** or boiler carryover loads too big for ordinary traps to handle (up to 300,000 lbs/hr).
2. **They are relatively small size**—the No. 237 compound trap is only twice the height and size of the largest Armstrong standard trap, yet has many times the capacity.
3. **There are cast or forged models for any pressure up to 600 lbs.**
4. **They are simple, dependable and trouble-free**—the inverted bucket pilot mechanism is the same as the mechanism in standard Armstrong traps, proven in thousands of installations. This mechanism plus a simple piston and large main valve is all there is to it. All parts are made of special wear-and-corrosion resistant steels.
5. **They are easy to install.**
6. **They can be completely overhauled without removing from the line.**
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8. **They are guaranteed to give complete satisfaction.**

Your local Armstrong Representative is fully qualified to answer your questions about these traps and their use. Give him a call, or write:

ARMSTRONG MACHINE WORKS
812 Maple St., Three Rivers, Michigan

Armstrong cast semi-steel compound trap draining coils of large storage type hot water heater.

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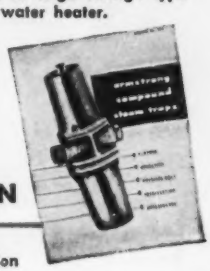
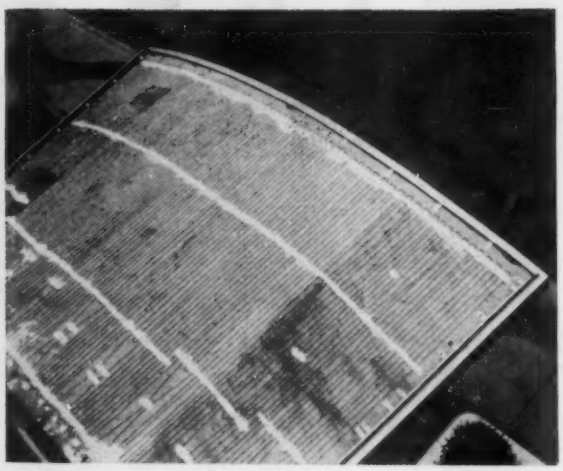


For complete information ask for 8-page bulletin, No. 215 . . . explains and illustrates operation and installation of Armstrong Compound Traps; includes physical data and list prices. Free on request—no obligation.

ARMSTRONG INVERTED BUCKET STEAM TRAP

ARMSTRONG STEAM TRAPS

Canopy here is kept ice free . . .



by electric heating cable on shell

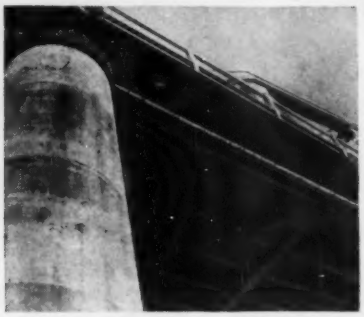
HOW TO

melt snow and ice with electricity

► Now, electric heating cable keeps pipelines, sidewalks, roofs and other exposed areas free of ice and snow. Canopy of building in photo has 1600 ft of plastic-covered wire. With only 8 kilowatts used at infrequent intervals, melting costs are very low for this application.

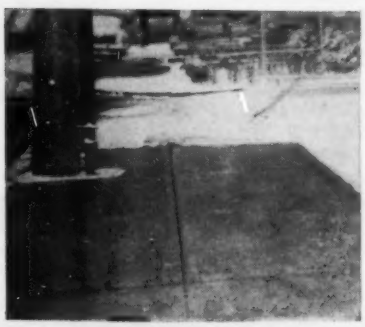
Cable can be used several ways, either embedded in concrete for ramps and sidewalks to keep ice and snow melted, or wrapped around piping to prevent liquid inside from freezing. One such application is cable-wrapped around a 150-ft section of supply line attached to under side of bridge. Location would be inaccessible for any other heating method. Before cable was applied, water had been freezing in last 55 ft of travel. Now, a continuous supply of water is assured by energizing the 180-kw installation when required by weather conditions.

Courtesy: Edwin L Wiegand Co, Pittsburgh, Pa.



Wired pipe does trick

Ramp is snow and ice free . . .



as is factory sidewalk

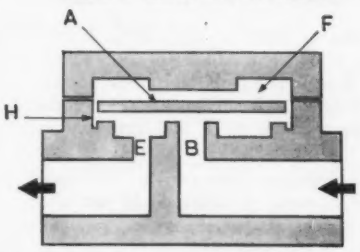
SARCO
Thermodynamic
STEAM TRAP

ACTUAL SIZE

this new trap virtually eliminates maintenance

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation, pressure in tube B raises disc and cycle is repeated.

The Sarco Thermodynamic Trap has proved successful on steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, separators and casing drains; alternate heating and cooling applications.

2098-B

A solid stainless steel disc—practically indestructible—is the only moving part!

Most striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part – a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air – snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for trial. All you do is fill out the coupon and mail it in.

SARCO COMPANY, Inc.
Empire State Building, New York 1, N.Y.

MAIL COUPON TODAY FOR TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for a 60-day trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

For installation on.....

NAME_____

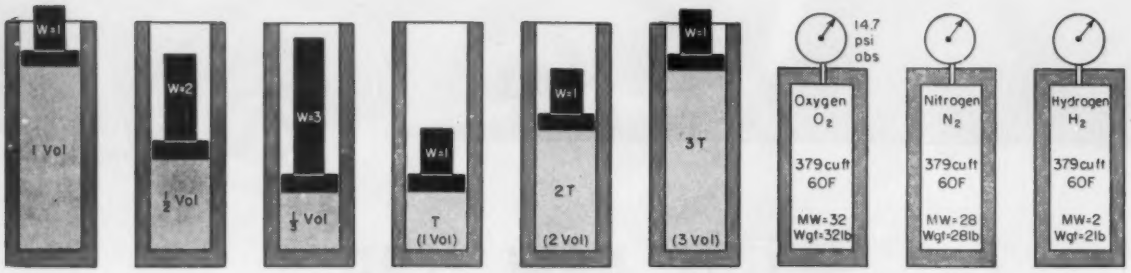
FIRM_____

ADDRESS_____

CITY_____ STATE_____

HEADWORK

PHIL SWAIN BRINGS ENGINEERING THEORY DOWN TO EARTH



Boyle's law
At constant temperature, the volume is inversely proportional to the absolute pressure (gage + 14.7 psi)

Charles's law
At constant pressure, the volume is directly proportional to the absolute temperature (F + 460)

Avogadro's law
At same conditions all gases have same number molecules per cu ft, so density is proportional to molecular weight

Combustion Facts-8:

The three gas laws

► ALL ENGINEERS know: (1) heating expands a gas (2) compression reduces gas volume and (3) heavier gas molecules increase gas density. Here are the exact laws for a perfect gas. These hold closely for oxygen, nitrogen, hydrogen, carbon dioxide, etc, under average conditions.

Boyle's law refers to compression *without change of temperature.* If you heat gas by compression, Boyle's law holds *after gas has cooled to its original temperature.*

Doubling the pressure cuts volume in half. Tripling pressure cuts volume to one third. If you divide pressure by 4.6, gas expands to 4.6 times the original volume.

Be sure to measure pressure in absolute psi (gage plus 14.7). For pressures well above atmosphere, it is close enough to add 15 psi to gage.

Charles's law. Next, hold the volume constant, as in a closed tank or in a cylinder under a fixed piston. Raise or lower temperature, and pressure will change in exact proportion. *Here both pressure and temperature must be absolute.* Absolute temperature is F temperature plus 460.

Problem: Assume any gas in a tank of any size. Starting condition is 200-psi gage (215 psi abs) and ambient temperature is 60 F (520 abs). What happens to pressure when sun heats tank to 120 F (580 abs)?

Temperature ratio is 580 ÷ 520 = 1.12. This, multiplied by 215 psi abs, gives 241 psi abs, or 226-psi gage pressure in the warm tank.

Avogadro's law. Other things being equal (pressure temperature and volume), the weight of a gas is proportional to the molecular weight. Following are the molecular data for common gases:

Gas	*Formula*	*Molecular weight*	*K (see text)*
Hydrogen	H_2	2	5.35
Oxygen	O_2	32	0.335
Nitrogen	N_2	28	0.382
Air (equivalent)		28.8	0.371
Carbon dioxide	CO_2	44	0.243
Carbon monoxide	CO	28	0.382
Methane	CH_4	16	0.669

Thus, oxygen is 16 times as dense as hydrogen. If you take 379 cu ft of any gas at 60 F and 14.7 psi abs (atmospheric pressure), weight in pounds equals molecular weight. So 379 cu ft of oxygen weighs 32 lb. Then oxygen weighs 32 ÷ 379 = .0844 lb per cu ft at 60 F and atmospheric pressure.

Combination law. The three gas laws can be combined into a single formula that is easily memorized. If you also remember the molecular weight of common gases, you can work simple gas problems in the field without reference to books or tables—which is often a very great convenience.

Here is the combined formula:

$$PV = KWT$$ where

P is pressure, psi absolute
V is volume, cu ft
W is weight, pounds
T is temperature, absolute F

K is a constant for a given gas = 10.7 ÷ molecular weight (for example, K for air is 10.7 ÷ 28.8 = 0.37)

If you know any three of the four variables you can solve for the unknown, thus,

$P = KWT/V \quad V = KWT/P \quad W = PV/KT \quad T = PV/KW$

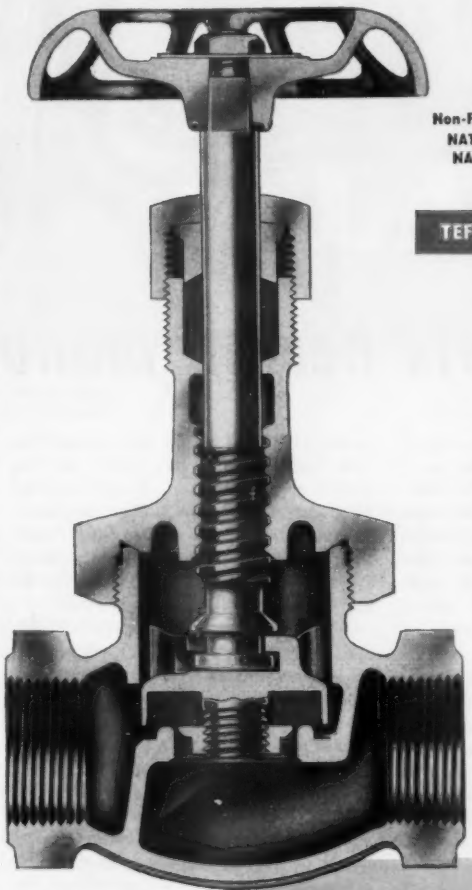
This "Hospital Valve" for OXYGEN now serves many industrial needs . . .

JENKINS Fig. 504 Bronze Globe with TEFLON disc and packing

Jenkins Fig. 504 was designed for the critical requirements of controlling oxygen, nitrous oxide, or any non-flammable gases in hospital services. Industry was quick to note its unique advantages, and it is now frequently specified for systems carrying gaseous fluids for heating, cooling, lighting, and processing, where pressure does not exceed 400 psi, or temperature a maximum of 150° F.

Fitted and tested to comply fully with all Association specifications for hospital services, Fig. 504 has the "extra value" construction throughout that is assured by Jenkins quality standards.

Get details — find out how Fig. 504 can improve efficiency and economy in your hookups for critical service. It's another example of the broad range of "valves for every service" in Jenkins' complete line.



Complies fully with "Standards for Non-Flammable Medical Gas Systems" of—
NATIONAL FIRE PROTECTION ASSOCIATION
NATIONAL BOARD OF FIRE UNDERWRITERS
AMERICAN HOSPITAL ASSOCIATION

TEFLON Disc and Packing

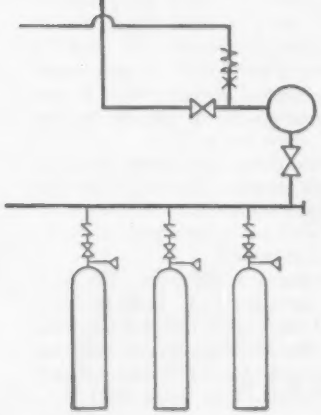
DuPont "Teflon" is a tough, "waxy" inert solid, gray-white in color, tasteless and odorless, non-adhesive and frictionless. Teflon's high resilience assures perfect contact of disc with lapped, crowned seat for gastight closure. Packing is one-piece ring of Teflon, provides dependable leak-proof seal with light compression.

Reinforced Body Casting
High strength bronze body is ribbed along bottom centerline providing extremely high factor of safety. Guards against distortion from vibration, shock, or pipe strains.

Degreased
All bronze parts are thoroughly degreased before assembly.

Polished Spindle
Alloy bronze spindle is polished to permit easy turning and assure leak-proof seal.

Sizes
— ¼" to 2" — 400 lb. O.W.G.



GET COMPLETE INFORMATION from your Jenkins Valve Distributor, or write: Jenkins Bros., 100 Park Ave., New York 17. Ask for Bulletin 116.

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LOOK FOR THE JENKINS DIAMOND
VALVES
SINCE 1864 TRADE JENKINS MARK
Jenkins Bros

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS EVERYWHERE

"Bull seemed weary and shaken. He removed his chart and replaced it with a new one for Marmaduke."

Marmy puts her on manual

► "BILGEWATER on automatic controls," roared Marmaduke Surfaceblow as I stepped into Bedlam's Bent Propeller Bar the other evening for a sandwich and beer before putting our September issue to bed. "You stationary engineers have been letting automatics do your brainwork so long you'd be fish out of water if you had to run your plants on hand control for a change."

I don't know what caused that outburst, but it looked like the old consulting engineer had finally put his head into a bear trap. For standing at the other end of the crowded bar was no less a character than Bull McGurk, chief engineer of the giant U.S. Chemical Co. across the Hudson River at Hoboken, N. J.

And McGurk wasn't called Bull for nothing. He not only looked the part, but he also had a reputation for pulverizing anyone who rubbed his fur the wrong way. And that barrel chest of his didn't come from pushing a pencil over a desk either. He got that way shoveling coal as a shift fireman and beating up tough characters in the Hell's Kitchen section of New York City at an age when other kids were in high school.

For over a dozen years, Bull had been chief of the chemical works' modern power plant and no one who worked for him had anything but praise for his ability as an operator. What they said about him as a person, behind his back, was something else again. Bull nursemaided 300,000 pounds of high-pressure steam in that plant and boasted that he had never had a forced shutdown.

When Marmy made that crack the Bull was just about to finish off a glass of his own brand of boiler compound —but he didn't finish. That challenge plugged his air duct and he almost choked on his drink. When he stopped blowing his gasket, he slapped his glass on the bar and made a beeline for Marmy, who had turned back to the bar and worked up a 28.5-in. vacuum on his bottle of Sandpaper Gin. By then the place was electric with high-voltage excitement.

For the first time since anyone could remember, it looked like Marmy would have to swallow his words, or be in for a knockdown drag-out fight.

"I'm a stationary engineer, you baboon," yelled Bull, when he got to Marmy. With that he pulled off his coat, rolled up his sleeves and rested his huge clenched fists on his hips. "And I wouldn't take that insult from my own grandmother and that's that, see?"

Marmy turned around slowly and pulled himself up to his full height of 6 feet, 4 inches. He looked calmly down at Bull, who was a mere shrimp of 6 feet, weighing a frail 220 pounds.

While everyone crowded around to see the battle of the century, Marmy leisurely put his induced-draft fan on his cigar, then just as leisurely blew a cloud of Number 8 Ringelmann smoke into Bull's face, blacking him out completely.

When Bull stopped coughing, Marmy roared, "I said that you don't know how to run a plant on hand control. And to prove it, I'll go to any plant you pick and run it on hand control for an hour, against an hour for you. And if I don't have a more even steam-pressure line than you—I'll blow you to a case of Sandpaper Gin. Or you can buy me one if I show you up."

"Another thing," thundered Marmy to everyone's surprise, "After I collect the bet, I'll take you on for some more hand-control work out in the street—if you're still in the mood."

Well, that was different. The shoe was on the other foot. Looked like it was Bull who walked into that bear trap and not Marmy. For a second, Bull said nothing—and Marmy calmly turned

(*Continued on page* 208)

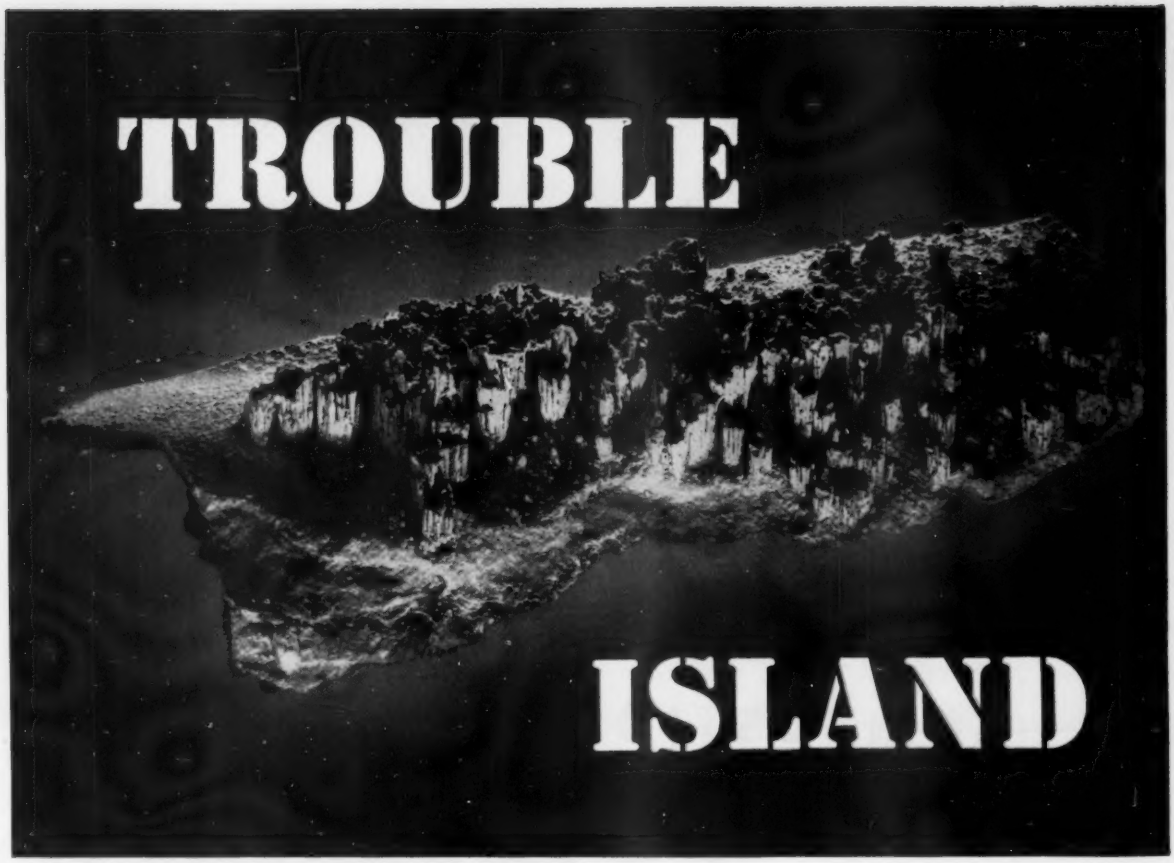

Photo is of a condenser-tube scale sample, about eight inches long. Solid scale is approximately ¼-inch thick, with "spires" ranging up to ⅜-inch height.

FIFTEEN years ago, this small island of trouble was part of a much larger open-box condenser problem at a refinery. Cooling water, running over 200°F. at outlet, contained 30 grains per gallon hardness and 20 parts per million iron. Tubes scaled heavily and rapidly without chemical inhibitor. Even with the best inhibitor then known, results were as illustrated above: partial inhibiting action creating the "spires" or forest-like deposits on tubes.

Considering this a challenge, Nalco sent a Doctor of Physical Chemistry—an expert water technologist—to the refinery. His weeks of work on the spot led to basically different treatment with new chemicals which cleaned up the condenser and kept it clean. Further Nalco research and development of chemical inhibitors has since enabled cooling systems to operate without scale or corrosion *with water hardnesses as high as 200 grains per gallon.*

Point is this: neither Nalco nor anyone else had an answer to scaling in that condenser. Nalco put the necessary brains to practical use and *got results* . . . benefiting, in the long run, not only that particular refinery, but every user of cooling water.

Whether your water treatment problem is unique, or stubborn plant-run, you will get prompt, decisive action from Nalco in the direction of positive results. Write or telephone today.

NATIONAL ALUMINATE CORPORATION
6227 W. 66th Place • Chicago 38, Illinois
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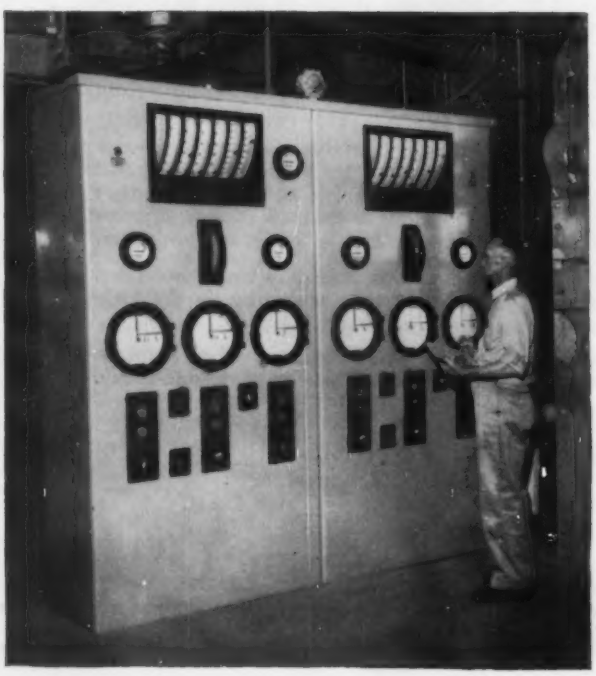
THE Nalco® SYSTEM . . . Serving Industry through Practical Applied Science

Boiler room at Kansas State College. Republic instrument panel is at left. Boilers are arranged for either gas or oil firing.

REPUBLIC *Automatic*

COMBUSTION CONTROLS

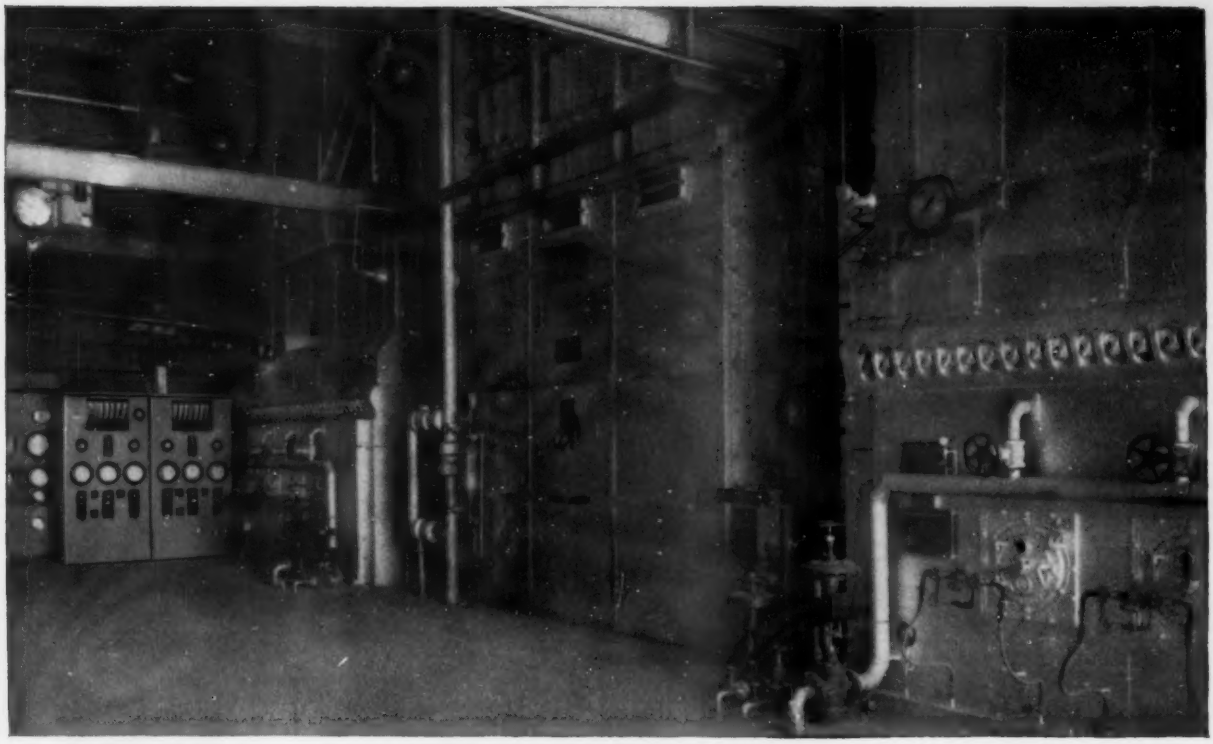
Go to College to



● At Kansas State College, a complete Republic combustion control system, feedwater level controls and instruments automatically operate two 50,000 pounds per hour boilers for maximum combustion efficiency. Fired by either oil or gas, these boilers generate steam at 225 psig and 500° F.

With Republic automatic combustion controls in this power plant, all loads,

Instruments on the control panel monitor boiler operation. If desired, the entire combustion system can be operated manually from this panel.



Cut Steam Costs

including "peaks", are met smoothly with steam output exactly matched to demand. Fuel costs per pound of steam produced are kept at a minimum 24 hours a day, seven days a week. Maintenance costs are kept low, too, by *continuous* proper operation of the boilers.

Whatever the size of your boiler, its draft arrangement, type or types of fuel to be fired and load conditions to be met, there's a Republic combustion control system that can bring these advantages to you. Our engineering staff, with more than 37 years *specialized* experience in combustion control systems, is at your service to help you get the system that exactly meets your needs. For your convenience, there's a nearby Republic field engineer to bring you all the facts. Write and make a date to see him soon.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

Speaking of power

personal slants on doings of interest to power men—some significant, some just odd

Atomic Energy Act, in revised form passed by Congress, permits private industry to own nuclear reactors, use fissionable materials, tap government data sources. This long-sought liberalization should speed discovery of new uses for the atom and encourage development of known uses, such as power generation.

To many of us in the power field, what's been accomplished in other fields may come as a surprise. Use of radioisotopes for measuring, testing, sterilizing etc, is already saving industry $100 million a year, says Commissioner Campbell, of AEC. And he estimates savings may reach a billion in ten years.

'T aint so! That's what Howard Hayes of Southern California Edison says about the first California hydro plant being on Angel's Creek (SP, June 1954). Pomona plant of San Antonio Light & Power Co, one of Southern California Edison's predecessors, began operation Nov 29, 1892. This single-phase plant, says Hayes, was first hydro unit in California for high-voltage transmission.

Not quite a year later (Sept 7, 1893) Mill Creek No. 1 went on the line – the first 3-phase hydro plant in the U.S. It was built by Redlands Electric Light & Power Co, another water-power ancestor of Southern California Edison.

Seagoing gas turbines are getting another whirl in the U.S. merchant marine. In two moth-balled Liberty ships, turbines will replace reciprocating steam engines to boost power from 2500 to 6000 shp. Into one will go a General Electric gas turbine modified for marine service. In addition to being the largest gas turbine in any merchant vessel, it will drive the biggest controllable-pitch propeller ever used in the U.S. Second vessel will be steam-turbine equipped.

Sewage-plant effluent found another interesting industrial use recently when summer drought in Illinois threatened Carter Oil Co's plans for extending its program of water flooding to increase recovery from oil wells.

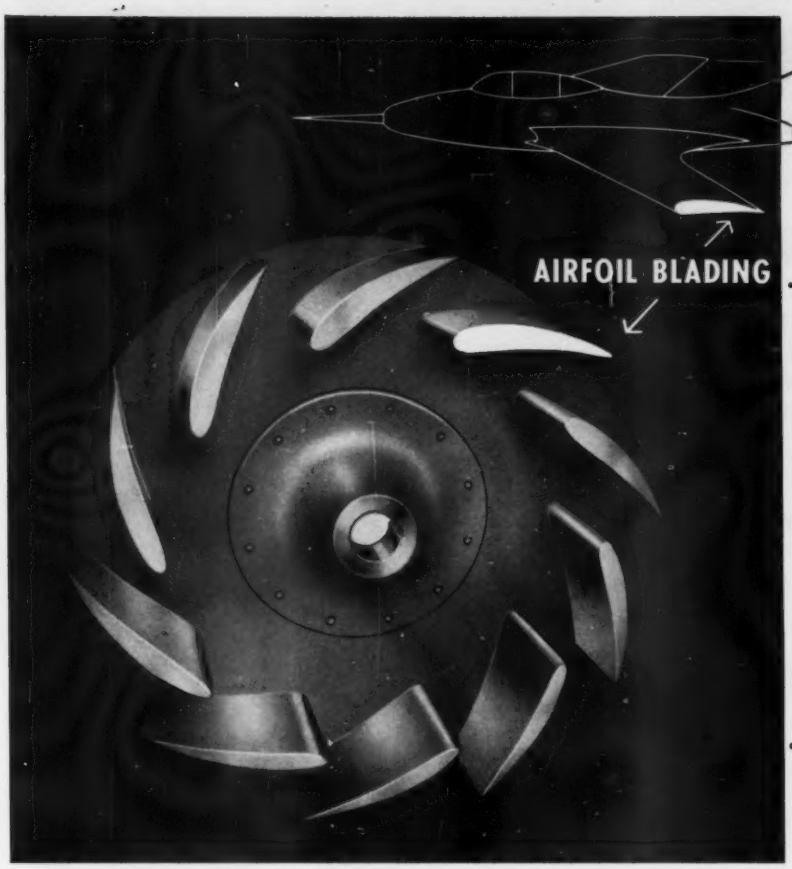
Carter laid 3.5 miles of 8-in. pipe from the Mattoon sewage plant, contracted for its discharge. With some additional treatment, this gave Carter the water they needed. As pointed out in Power's special report on "Water" (Sept 1952) such arrangements offer a good solution for many industrial water problems.

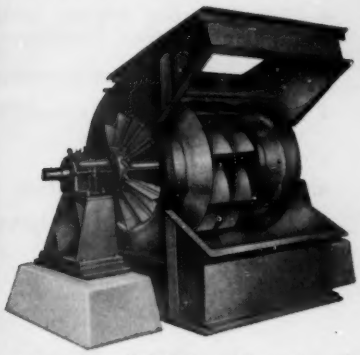
Powdered-iron piston rings will soon be offered commercially by Muskegon Piston Ring Co, after some 14 years of research and about two of experimental production. Process starts with metal powder finer than flour, which is compacted to shape in a press, then sintered in a controlled-atmosphere furnace. At no time does the metal actually become molten.

While metal powders are still relatively costly, there's little or no waste and drastic savings in space for storage and production. Powder metallurgy promises thinner rings than can now be cast, rings with the lower contact area today's engine designers seek.

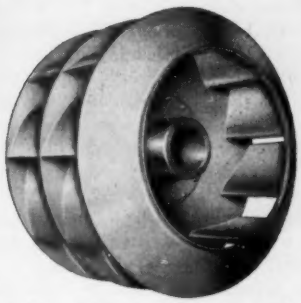
Los Angeles atmosphere receives something like 3100 tons of chemical materials daily, emitted by the activities of the public and of industry. Stanford Research Institute estimates that about 1500 tons of this total are hydrocarbons, with about 1180 tons coming from auto exhausts and about 275 tons from operations of the oil industry. Backyard incinerators alone contribute about 400 tons of organic matter daily to the blue skies over Los Angeles.

Lou Lowley





Heavy-duty Airfoil fan with section of housing removed to show wheel assembly. Air Volume is controlled by inlet vanes.



Each Airflow Blade is die-formed and reinforced to insure maximum rigidity.

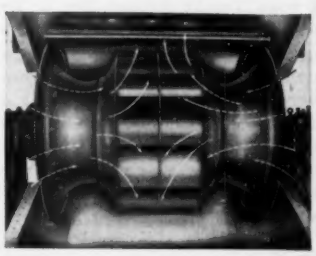
Aerodynamics applied to centrifugal fans:

Westinghouse Airfoil Blading Boosts Fan Efficiency to 92%

Quieter operation, too, for all heavy-duty applications

Westinghouse incorporates the airflow principle of an airfoil section into centrifugal fan wheel design to produce exceptionally high fan efficiencies! Performance proved, this Non-overloading Centrifugal Fan with Airfoil Blading reaches peak mechanical efficiencies of 92 percent . . . cuts noise level as much as 65 percent! Here's why: streamlined inlets that give smooth, full flow of air to the wheel . . . revolutionary Airfoil blades . . . improved housing that reduces turbulence. Benefit to you: a high-efficiency fan that pays for itself through yearly power savings.

This remarkable fan insures low operating cost and quiet operation in mechanical draft . . . high-velocity air conditioning systems . . . heavy-duty industrial applications . . . vehicular tunnel ventilation. For full information, contact your local Westinghouse-Sturtevant office, or write: Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Mass.



Airflow into, through, and out of fan is completely streamlined. Result: maximum air output per horsepower input.

WESTINGHOUSE AIR HANDLING

YOU CAN BE **SURE** . . . IF IT'S Westinghouse

J-80420

READER SERVICE SECTION

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New Special Events:

- **Dinner meeting of Plant Engineers Club of Greater Philadelphia**
- **ASME inspection trip to Fairless Works of U.S. Steel Corporation**
- **All-day symposium on Automation**
- **Joint meeting of the Philadelphia sections of ASME and ASCE**

and more than 250 exhibits of new and improved equipment

all at the...

1954 National Power Show in Philadelphia

► SPECIAL EVENTS will highlight the last National Exposition of Power and Mechanical Engineering. The "Power Show" moves to Philadelphia this year as its old home, New York's Grand Central Palace, has been rented by the government. Exhibitors voted the move to take advantage of superior facilities at Philadelphia's Commercial Museum, located at 34th and Spruce Sts. All exhibit space will be on the ground floor, with ample accommodations for electrical and mechanical services.

The exposition is timed to make attendance at both the annual meeting of the American Society of Mechanical Engineers and the Power Show a convenience. The ASME meeting in New York runs Nov 29 through Dec 3; the Power Show runs Dec 2 through Dec 7, being closed Sun, Dec 5. Other special events have been announced as follows:

Thursday, Dec 2—Dinner meeting of Plant Engineers Club of Greater Philadelphia at Commercial Museum.

Friday, Dec 3—ASME members at the annual meeting will visit the Power Show after an inspection trip of the Fairless Works of U.S. Steel Corporation. Also, an all-day symposium on Automation will be held by the Instrument Society of America at Commercial Museum. Such topics as "Trends," "New Problems Created by Automation," "Automatic Intelligence Gathering Systems," and an analysis of "The Engineering Control Loop" will be covered.

Monday, Dec 6—Philadelphia sections of ASME and ASCE will hold a joint meeting at the auditorium of Philadelphia Electric Co. A dinner at the Sylvania Hotel precedes the meeting.

Featured at the Power Show will be displays of some 250 manufacturers, comprising the entire field of power plant engineering and associated apparatus. First time exhibits include an *Autolog* that records operating performances at as many as fifty trouble points in plant operation. Displayed with the *Autolog* will be a supersensitive gas detector for accurate sensing of toxic or combustible gases in concentrations as low as five parts per billion.

A display of patented coordinated pumps and motors will reveal new possibilities in transmission of power through hydraulics. Up to three motors may be driven from a single pump, the motors affording high torque and horsepower. A selector valve provides complete speed variation and control from the positive displacement pump.

Model gas turbines, a cutaway steam turbine, electric motors, fans and blowers, and unit heaters will be exhibited. This display will be staffed by engineers available to discuss broader aspects of gas or steam turbine problems, air handling questions and queries on electric motor and control apparatus.

Other displays will include a series of newly designed plug-in control centers for power distribution in industrial plants; a line of socket type welded pipe fittings; and a motor rotation and phase tester for determining direction of rotation of electric motors before putting them on the line.

An innovation at the exposition destined to interest manufacturers and users of electrical equipment, is the first comprehensive line of instruments designed specifically for dc overpotential testing.

A newly designed packaged boiler, smaller in size than its predecessors, but with four-pass construction, will also command attention. Unit affords 5 sq ft of heating surface per boiler, assuring minimum guaranteed efficiency of 80%. A tube expander with taper rolls of proper length to roll tubes spaced in thin tube sheets will also be exhibited.

Show hours are as follows: Thurs, 2 PM to 10 PM; Fri and Mon, 11 AM to 10 PM; Sat and Tues, 11 AM to 6 PM; the show will be closed all day Sun, Dec 5. The exposition will be managed by International Exposition Co, 480 Lexington Ave, New York 17, N. Y. E K Stevens, president, is manager.

Developments in atomic energy to highlight NICB conference

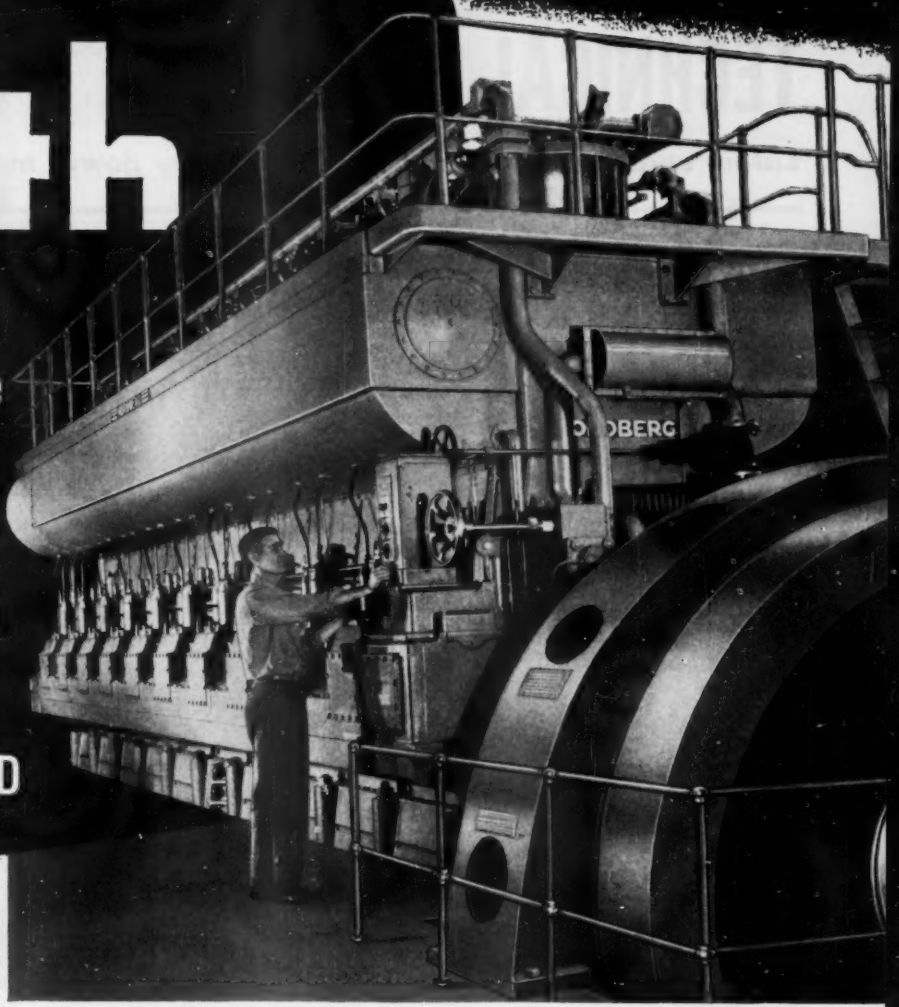
► MORE THAN 2000 leaders in government, science and industry from the United States and abroad will hear discussions concerning peacetime atomic energy programs of Belgium, Brazil, Canada, Denmark and France, at the National Industrial Conference Board's third annual conference on atomic energy. The meeting will be held Oct 13 to 15 at Hotel Commodore, New York.

In keeping with President Eisenhower's policy on international cooperation, this year's conference will explore foreign progress and prospects for worldwide development of peacetime uses of

(*Continued on page* 242)

4th

NORDBERG Duafuel® Engine helps Garland, Texas keep pace with INCREASED POWER DEMAND



• One of the fastest growing towns in the United States, Garland, Texas is composed of over 17,000 progressive minded citizens. Just 14 miles northeast of Dallas, Garland is located in the heart of the north Texas rich blackland farming region.

In keeping with this rapid growth, and with an eye to the future, responsible officials have made sure that Garland's power plant has maintained a steady increase in capacity, to meet the ever-increasing power demand.

Backbone of Garland's efficient, economical power generation facilities are four reliable Nordberg Duafuel® Engines, installed at intervals to meet the increasing demand. The most recently installed unit is a 2-cycle, 10-cylinder Nordberg low pressure Duafuel® engine rated 4,580 hp, 3,500 kw, at 240 rpm. This fourth Nordberg repeat order was preceded by another 2-cycle low pressure Duafuel® unit rated 3,010 hp, 2,100 kw . . . and two 4-cycle supercharged Duafuel® engines each rated 1,200 hp, 855 kw.

Today, with four dependable Nordberg engines capable of generating over 7,000 kw, citizens of Garland can point with pride at the continued growth of their city and its power facilities.

Next time you are thinking of power, think of Nordberg . . . builder of America's largest line of heavy duty engines, from 10 to over 10,000 horsepower.

NORDBERG MFG. CO., Milwaukee, Wis.

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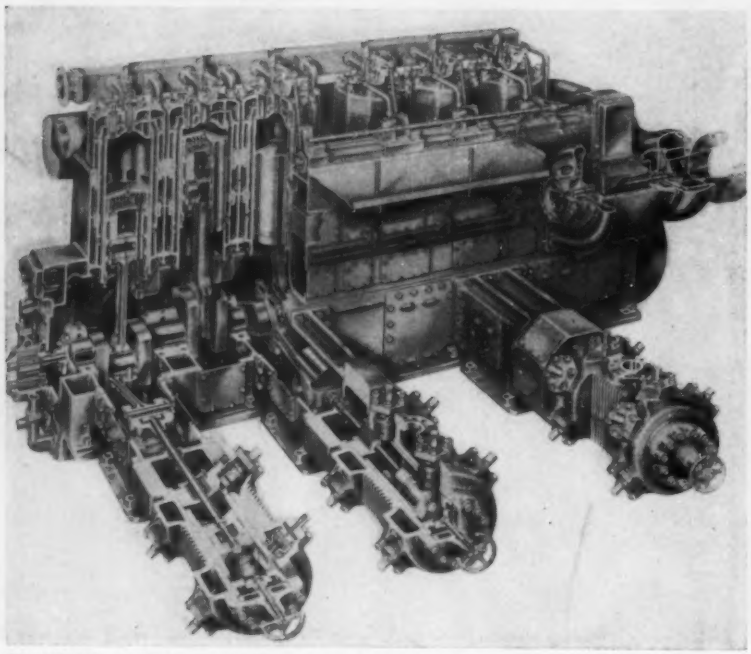
P754

TECHNICAL BRIEFS

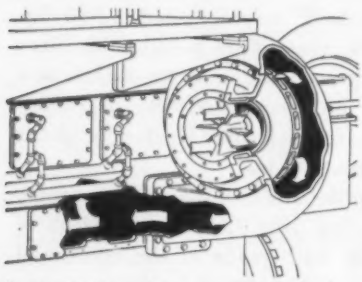
Latest engineering developments for busy power men

10 Digests for you on:
ENGINES
STEAM POWER
HEAT TRANSFER
WATER TREATMENT

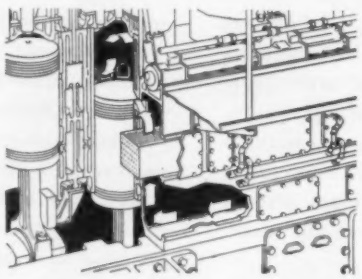
Turbocharging gives greater power output on less fuel



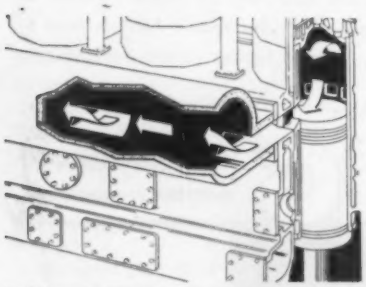
CUTAWAY of Clark *Model TLA-6* 2000-bhp gas-engine-driven pipeline compressor



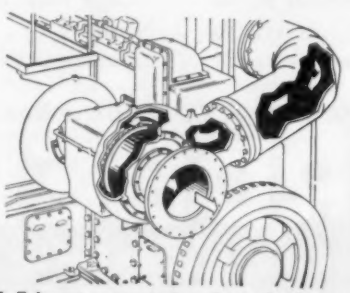
1 Air discharged to scavenging passage



2 Intercooler ahead of power cylinder



3 Exhaust gas leaving a power cylinder



4 Exhaust gas entering the turbocharger

Turbocharging two-stroke gas engines. *By C A Chamberlain and G H Bollman, Clark Brothers Co.*

With demand for natural-gas fuel for industry and home steadily increasing, there has been a sharp rise in gas prices at the wellhead. Efficiency of prime movers employed to move gas through major pipelines cannot be overemphasized.

Turbocharged two-stroke gas engines driving compressors are being used more extensively on pipelines. This paper details development of a new type of turbocharged gas engine for this service.

Though mechanical stresses increased only slightly over older designs, new engine shows a gain of 33% in brake horsepower. Engine is a completely redesigned unit using enbloc construction with removable power-cylinder liners. Air and exhaust passages at points of high-velocity flow approaching and leaving the cylinder-liner ports are carefully streamlined. This is essential for maintaining low pressure drop from blower discharge to turbine inlet.

Bearing sizes are considerably larger. This assures adequate surface for increased loads resulting from greater engine output.

A number of comparisons and performance analyses show how a design problem of this type is tackled. Charts illustrate how closely the theoretical analysis checks with actual performance of a number of engines. *ASME paper No. 54-OGP-7.*

Foundations for pipeline compressors. *By C E Holvenstot and S G Hagerman, Ingersoll Rand Co.*

While directed at pipeline compressors, this paper contains a number of good pointers useful in planning foundations for other internal-combustion engine installations. It reviews the generally accepted concept of elasticity of the ground and emphasizes importance of designing foundations to avoid resonance. Origin of inertia forces occurring in all reciprocating machines is fully discussed.

Engine and compressor manufacturers, as part of their regular procedure, send details of a foundation sized to ab-

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

He is your J-M Insulation Contractor... the man with the world's most complete insulation engineering service

"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

1. You get dependable materials—Johns-Manville manufactures a complete line of insulations for every service temperature from minus 400F to plus 3000F. From them your J-M Insulation Contractor can select the right insulation for the most dependable service on your job. To develop new and improved insulation materials Johns-Manville maintains the J-M Research Center—largest laboratory of its kind in the world.

2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

*Reg. U. S. Pat. Off.

Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

More TECHNICAL BRIEFS

Begins on page 162

Internal combustion engines

Continued from page 162

sorb unbalanced forces of the unit, if it is placed on good ground. If investigation or experience show ground at the site is good, no alteration of the standard plan is needed. Reduction of any standard dimensions is unwise, but increased length or width does no harm and provides added insurance.

Increasing depth or height of the standard foundation can cause excessive soil loading, and if carried far enough, rocking. If it is necessary to increase height or depth, foundation should be placed on a generous mat to increase surface contact and reduce soil loading. Mat must be sufficiently rigid to resist deflection. Stiffness is obtained by pouring ribs along mat length.

The standard foundation is unsuitable for soft ground. Cases like this should be referred to a foundation expert. To assist in design, compressor manufacturers will supply tabulations of unbalanced forces to be encountered. While solution depends on local variables, desired end effect will be low soil loading. *ASME paper No. 54-OGP-5.*

Cooling-water systems

Economic comparison of river and cooling-tower circulating-water systems. *By J Lichtenstein and B C Sprague, Santa Fe Tank & Tower Co.*

To compare two systems, it is first necessary to reduce them to a common economic basis. Of possible combinations included by two systems, those of minimum total costs must be found. Total expenditures include equipment costs, capitalized cost of power requirements and capitalized cost of system capability losses.

This paper describes a mathematical method using derived equations to calculate economic specifications on which computations for equipment with minimum total cost are based. Comparison between cooling-tower and river plants shows an existing cost differential. In most cases this can be eliminated by various savings that the cooling-tower plant permits, because there is relative freedom in choice of its location.

General factors covered include development of economic equations, economic condenser and cooling-tower series, prototype equipment, etc. Application of the method to two typical hypothetical plants on the Ohio River makes this paper a most useful tool for designers meeting similar problems. *ASME paper No. 54-SA-37.*

Directions for ordering papers are given on page 232

Design and operating aspects of central-station steam plants for midwestern fuels and loads

Design and operational aspects regarding utilization of North Dakota lignite in steam-generating units. *By H R Cowles, Otter Tail Power Co.*

Power requirements within the area for economic use of lignite are growing in a proportionate rate to the nation as a whole. Since 95% of the lignite reserves of the U.S., 463 billion tons, are in the Dakotas and Montana, power plant use of this fuel is largely confined to areas within economical rail distance from the mines. These reserves represent about 25% of U.S. coal reserves in tons and about 15% in terms of heating value. More than 3 million tons were produced in 1952 from 72 strip mines and 18 underground mines in North Dakota.

The size of boilers burning lignite is growing rapidly. Within four or five years there may be boilers of 500,000 to 600,000 lb-per-hr capacity. This is more than double the capacity of the present largest unit of 250,000 lb-per-hr capacity, still under construction. There is every reason to believe that before 1967 there will be 100,000-kw turbine-generator units supplied with steam from lignite-fired boilers.

Hydroelectric developments along the Missouri River will have little effect on supplying all power needs. Estimates for 1960 for Garrison Dam show a gross peak capability of 385,000 kw in July and a minimum of 180,000 kw in November and December. These will be considerable less during a dry year.

Present integration of the Missouri River hydroelectric generation and other major power systems will require fuel-burning plants to supply power deficiencies during low water and to meet peak demands for power that, in North Dakota, occur when there are restrictions on the carrying capacity of the river channel. *ASME paper No. 54-F-24.*

Developmental designs and operating experiences of the Oak Creek power plant. *By M K Drewry, Wisconsin Electric Power Co.*

This plant includes a number of unusual design features. Operating experiences are therefore of more interest than in usual plants.

Compactness, high efficiency, reliability and moderate cost are obtained in the turbine by having both stages of the 1000-F steam in the 3600-rpm section of the cross-compound turbine exhaust at an unusually low pressure, 10 psig, through a novel cross-under duct construction.

Use of a controlled-circulation boiler was based on safety and ability to cope with emergencies, even though its design is somewhat less simple than other types. Boiler circulating pumps require 25% of full-load output and are not without maintenance. But they have not been responsible for impaired outputs. Development is reasonably expected to reduce needed attention.

With 1000-F superheat and reheat steam throughout the load range, and self-cleaning of furnace surfaces, three waterwall platens assist in absorbing heat at high rates. Reliability, in general, is highest with coolest furnaces.

Pump costs were limited to 50% of kw cost at the company's Port Washington station. This was achieved by manifolding four pumps for four units, using higher speed pumps and designing the condensing-water system for minimum flow resistance after hydroelectric-plant practice.

Omitting backing rings from pipe welds reduced cost and improved safety. It also permitted helpful sonic testing.

Using two half-size boiler-feed pumps halved the cost, per plant kw, of previous practice. Boiler feedwater-regulation valves are located at the feed pumps, improving safety, regulation and reducing high-pressure heater cost.

Operating experience shows major objectives of new designs were reached without more than the normal trouble met with new power plants. Conventional apparatus and parts not influenced by design changes gave the major trouble. *ASME paper No. 54-F-24.*

Hydro development

Modern trends in the design of hydraulic turbine governors. *By B R Nichols, Allis-Chalmers Manufacturing Co.*

Design of many hydroelectric units still in operation after 40 years or more of service was based largely on good judgment of the designer and limited field experience. Modern hydroelectric

(Continued on page 228)

Are you keeping FUEL COSTS as low as you can?

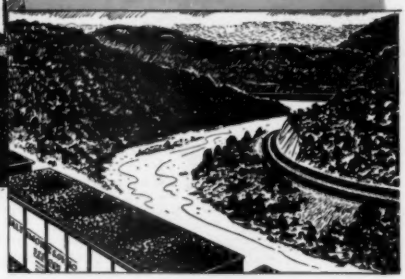
ASK OUR MAN!

He will demonstrate with *facts* why your best bet is bituminous coal. He will help you find the right kind and size of coal for your specific need; and he will show you up-to-the-minute ways of burning it efficiently and economically.

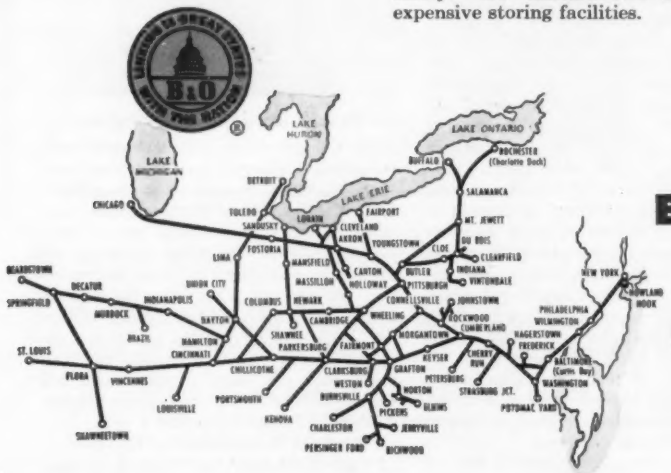
In Baltimore & Ohio territory, close to industry's doorstep, are bituminous coals in all varieties—for power, coking, steam, heating. Produced in highly mechanized mines, these coals are low in cost and uniform in size and quality. With the modern burning equipment now available, the efficiency and cleanliness of bituminous coal will amaze you!

Surprising economy. Conveniently accessible and highly efficient in modern use, bituminous coal from mines on the B&O keeps fuel costs low.

Convenient storage. Bituminous coal can be stored anywhere with safety. This eliminates the need for expensive storing facilities.



Reserves for centuries. Plants built for bituminous coal are assured a continuity of fuel supply regardless of emergencies. On the B&O alone, are reserves estimated at 25 billion tons!



Baltimore & Ohio Railroad

Bituminous Coals for Every Purpose

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Your information center for new products designed to solve plant problems

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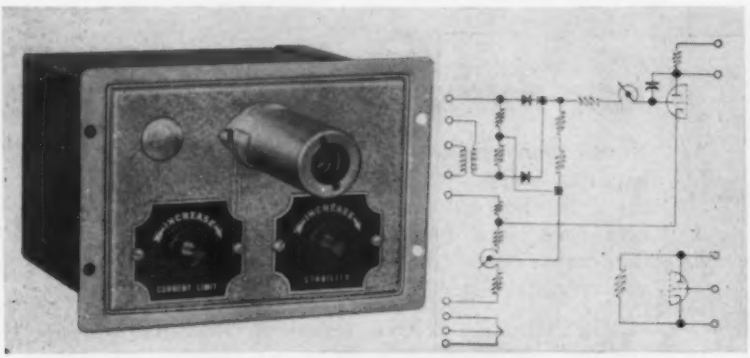
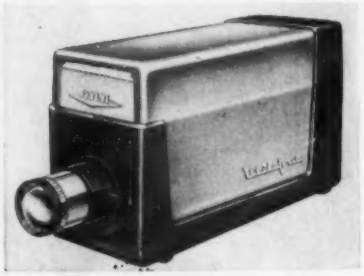


Packaged electronic circuits helps speed maintenance

1004 • A new development in electronic controls is the arrangement of various electronic circuits in separate units, known as *Sealpaks*. Method is said to give greater protection to electronic elements in controls and to facilitate ease and speed of maintenance. Each unit contains its own electronic circuit for its own particular purpose. *Sealpaks* are mounted on the panel, each independent from the other, and are interconnected by attaching leads to screw-type terminals. Components are sealed in plastic and encased in metal enclosure to provide protection against dirt, corrosive atmospheres, vibration and shock.

Greatest advantage of method is said to be simplicity of maintenance. When trouble occurs it is necessary to test only a relatively few connections according to a predetermined test procedure. *Sealpak* in which trouble lies is disconnected and replaced with new unit in a matter of minutes. Full details available on request to the manufacturer.

Reliance Electric & Engineering Co, 1088 Ivanhoe Rd, Cleveland 10, Ohio

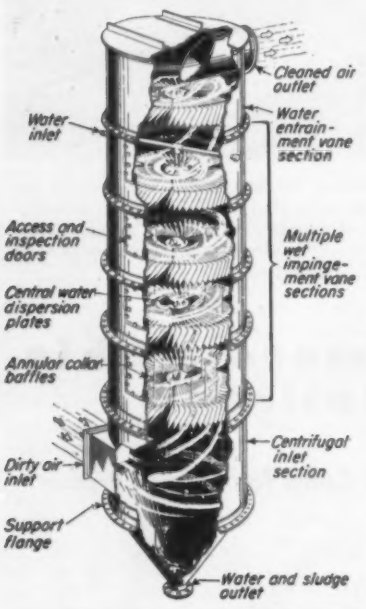


Industrial television camera

1050 • Closed circuit *UtiliVue, series 400,* camera can be used either with Video monitor or with standard TV receiver and can be tuned to any channel from 2 to 6. Controls and power supply are built into camera. No separate power unit or multiconducter cable is needed. Voltage regulation is built-in and camera has automatic illumination compensation.

Diamond Power Specialty Corp, Lancaster, Ohio

For more data on these items, use post cards p 175. Identify your request with item number.



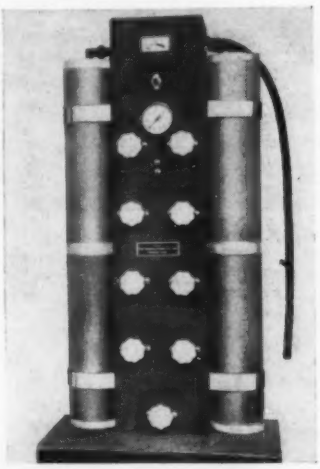
Wet-dust collectors

1023 • Centrifugal wet dust collector, *Type CW-1,* solves dust control problems that cloth type collectors cannot handle. These problems include high temperature or moisture; explosive or combustible dusts; corrosive, highly abrasive or obnoxious dusts; or a combination of the foregoing.

Collector is of counter-current design and of tower type construction. It consists of multiple wet vane sections and a final water entrainment vane section. Diameter of collector varies in proportion to air volume handled and number of wet vane sections is governed by application requirements.

Water supply enters above top wet vane section and flows downward or counter to upward flowing air, which enters collector through the lower tangential inlet. Patented vane is said to provide increased impingement surface and impart centrifugal action to both air and water to produce thorough intermixing. Water and dust are discharged as sludge from lower cone and clean air from air outlet at top. After clarification in settling tanks, water may be recirculated since no spray nozzles are used, the water inlet being an open end pipe.

Pangborn Corp, Hagerstown, Md.



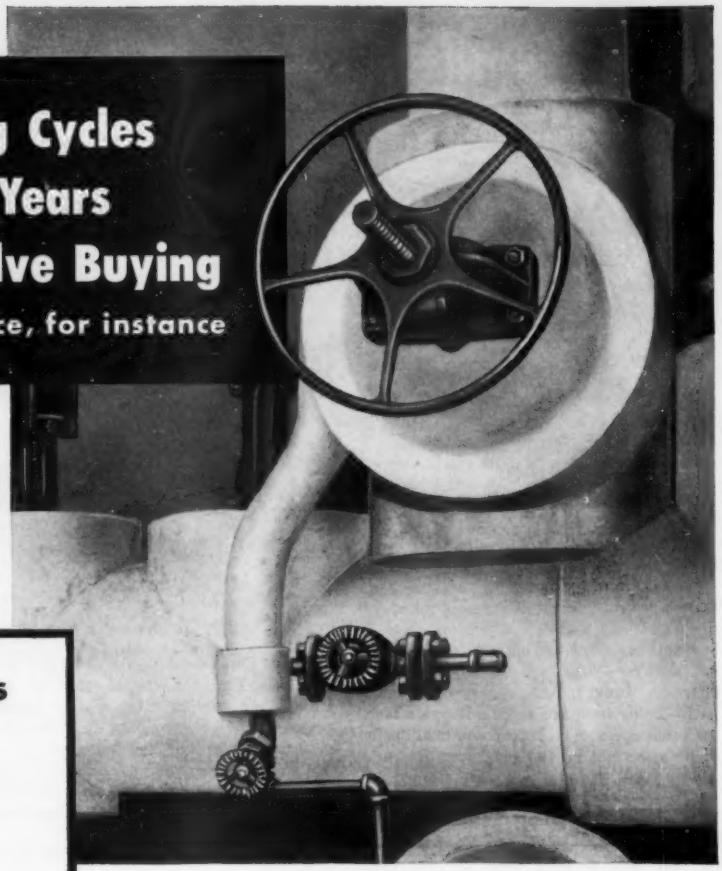
Bench model demineralizer

1051 • Regenerative type demineralizer is completely packaged unit requiring only 15x8-in. of counter space. Known as *Model L-20,* it will supply to 20 gph of super high purity water at a chemical cost of only pennies for each 100-gallons produced, according to manufacturer. Dual action design enables two columns to do work of four. Raw water is filtered through a stainless steel screen, then is given two demineralizations—passes through two columns, each containing a cation resin bed and an anion resin bed—to produce a dually deionized effluent of less than 1 ppm.

Penfield Manufacturing Co, Inc, 19 High School Ave, Meriden, Conn.

1248 Operating Cycles Through 24 Years Prove Quality Valve Buying

. . . for main steam service, for instance



The Installation

At the Champion-International Paper Mill, Lawrence, Mass., featuring Crane 400-pound steel gate valve in main steam line to turbine. Working pressure: 400 psi at 600 deg. F.

Valve Service Ratings

SUITABILITY: Never a question

FEATURES: Quality throughout

MAINTENANCE COST: Not a cent

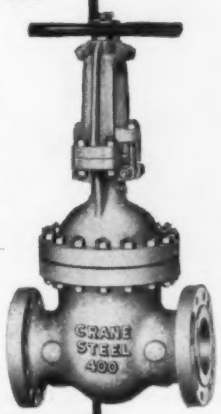
SERVICE LIFE: 24 yr.—still in line

OPERATING RESULT: Lower power costs

AVAILABILITY: Regular Crane Catalog item

The Valve

Improved constantly through the years, Crane steel valves for elevated pressures and temperatures are known and respected everywhere for outstanding, low-cost performance. They're made in the widest range of body and trim materials—in all pressure classes and sizes—with screwed, flanged, or welding ends. See your Crane Catalog, or consult your Crane Representative.



The Case History

Installed in 1930, this Crane valve has been in continuous use ever since. In 24 years the valve has not required service or maintenance of any kind.

More significant is the quality of performance of this 8-in. steel gate valve. Operated for week-end shutdown of the turbine, it has never failed to respond to the handwheel with smooth, steady action. Both seating and stem seal remain as tight as when the valve was first installed.

Performance like this begins in just one way—by making quality the first consideration when buying valves. Today, such a buying policy is sounder than ever and Crane quality, more than ever, helps assure the best results at lowest ultimate cost.

THE BETTER QUALITY . . . BIGGER VALUE LINE . . . IN BRASS, IRON, STEEL

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

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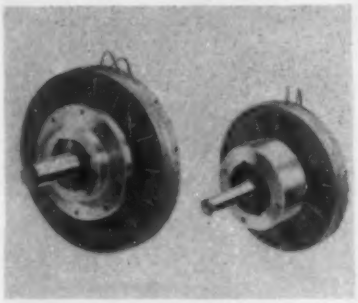
Begins on page 166



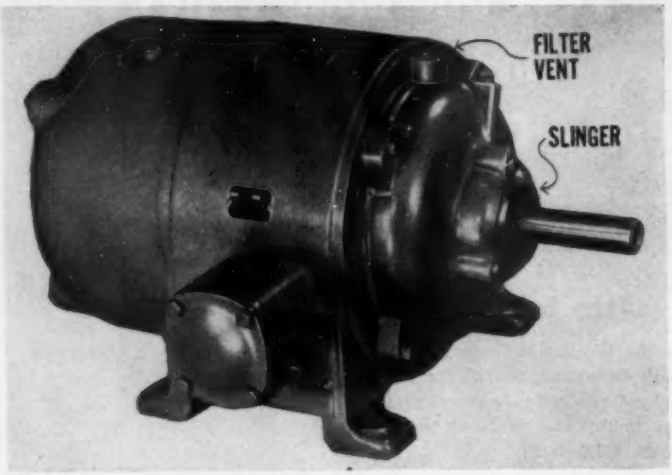
Electric brakes and clutches

1020 • Replaceable face brakes and stationary field clutches are available in sizes with torque ratings from 8 lb-in. to 700 lb-ft. Brake features replaceable facing, similar to lining found in automobile brakes. This feature is said to make it possible for brake to last as long as any machine on which it is installed, since the only part subject to heavy wear—the facing—can be easily changed. Brake contains only three main parts: field, armature and replaceable face.

Clutch operates on "stationary field" principle, a method for inducing current into a rotating coil. No slip rings are needed.

Warner Electric Brake & Clutch Co, Dept PR, Beloit, Wisconsin

For more data on these items, use post cards p 175. Identify your request with item number.

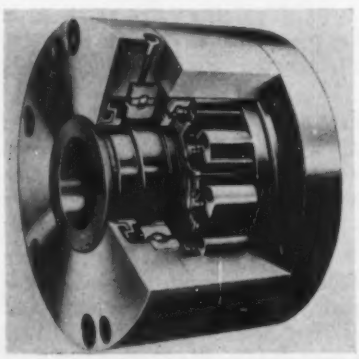


Totally enclosed motor is designed for taconite mill service

1005 • Enclosed motor is designed to resist deleterious effects of taconite dust. Unit is available with or without internal gearing. In the new motor shaft seals have extra long sleeves of close tolerance and are made of non-magnetic material. End brackets and retaining bolts are compound-sealed to obtain nearest approach to a hermetically-tight joint.

Because completely enclosed motors have a tendency to "breathe" when heating and cooling, which may cause taconite and/or moisture to intrude, housing has a filtered path of low resistance. Any air drawn in during expansion or contraction follows the filter path, and does not pass through bearings. These filter areas completely seal out taconite and other dusts, according to manufacturer. Descriptive literature available on request to the company.

U.S. Electrical Motors Inc, Box 2058, Los Angeles 54, California

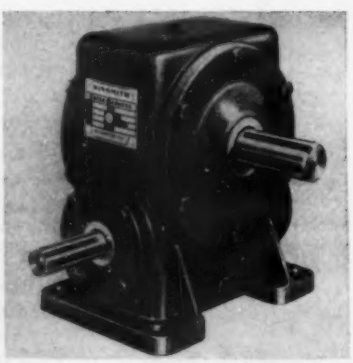


Heavy duty cam clutches

1022 • Ball bearing overrunning clutches, *Series K*, are available for indexing, backstop and general duty machinery application. Extra heavy duty units have toothed inner race driving member that actuates closely spaced independently sprung cams. Typical applications include dual, two-speed, forced, induced and ventilating fan drives in power plants and heavy industries.

Tapped holes in ends of clutches permit attaching sprockets, gears, pulleys or ratchet arms for drive requirements from 1300 to 6000 ft-lbs. Full details on request.

Morse Chain Co, 7601 Central Ave, Detroit 10, Michigan



Compact speed reducers

1012 • Worm gear speed reducers, *C line*, are said to provide greater capacity within more compact dimensions. Three designs in 13 sizes are to be manufactured. First five sizes, within the 1/100 to 5 hp range, in ratios of 5:1 to 60:1, are available and balance of sizes will be available soon. Manufacturer states that with greater capacity built into each size reducer, smaller units may be used to meet individual requirements in many instances. Units are equipped with gears, bearings and shafts rated for AGMA Class 1 service. Request bulletin HW 654 for further information.

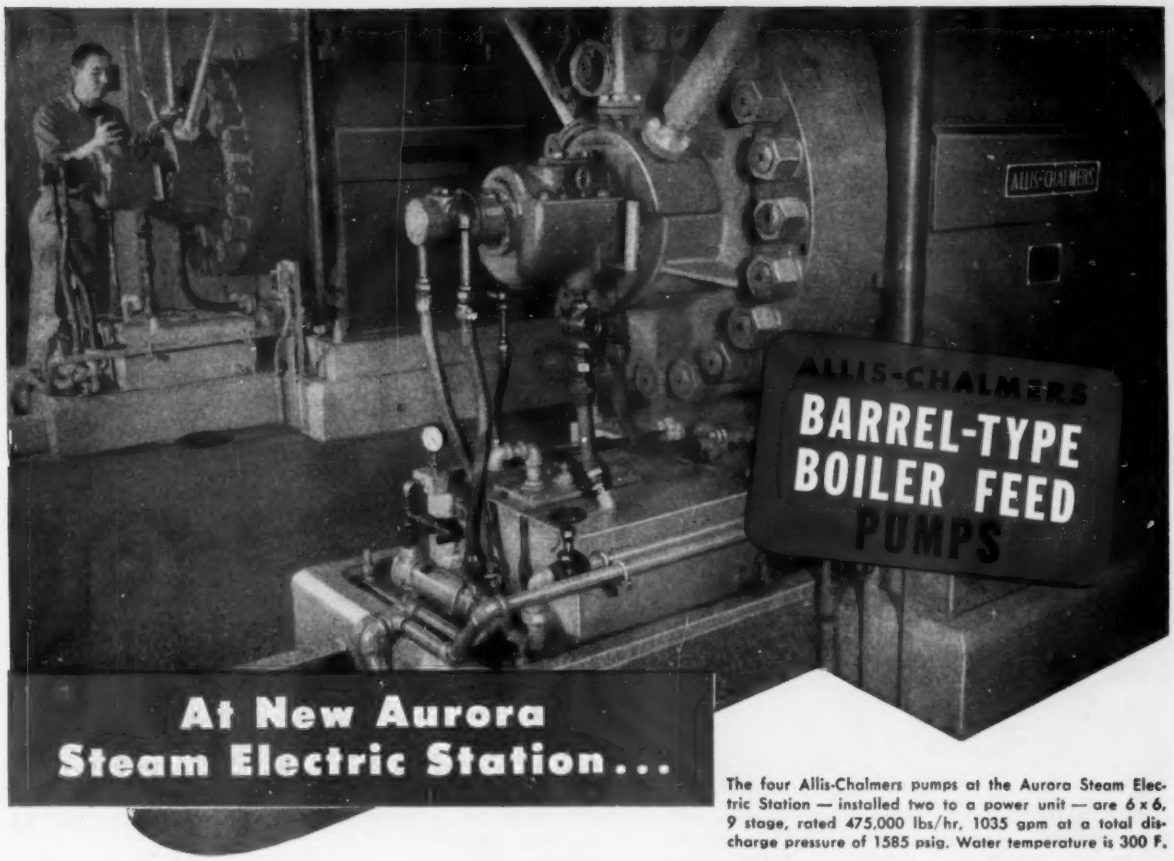
Winsmith Inc, Springville, N. Y.

Vertical speed reducers

1013 • Vertical *Shaft-King* speed reducers are shaft-mounted units designed for applications where driven machine shaft is in a vertical position or nearly so, such as on mixers, agitators and liquid processing machines. Units are available in 13:1 and 20:1 ratios for requirements through 42 hp.

Reducers can be supplied with torque-arm overload release that gives complete protection to driven machine, motor and drive, for operations where jam, choke or shock loads may occur. Further information available on request to manufacturer.

The American Pulley Company, 4200 Wissahicon Ave, Phila. 29, Pa.



At New Aurora Steam Electric Station...

The four Allis-Chalmers pumps at the Aurora Steam Electric Station — installed two to a power unit — are 6 x 6, 9 stage, rated 475,000 lbs/hr, 1035 gpm at a total discharge pressure of 1585 psig. Water temperature is 300 F.

Minnesota Power & Light Installs 4 of these Highly Reliable Pumps

THE NEW 88,000-KW AURORA STEAM ELECTRIC PLANT at Aurora, Minn., is a model of modern design and efficiency. Equipment was carefully chosen for its ability to provide extra dependable, low-cost operation.

On this basis Minnesota Power & Light Co. — working with its consulting engineers, EBASCO SERVICES INCORPORATED — bought four Allis-Chalmers barrel-type boiler feed pumps.

WHAT ARE YOUR PUMP NEEDS?

Whether you require boiler feed, condensate, circulating or other power plant pumps — a careful study will reveal why more and more utilities are specifying Allis-Chalmers. Check the design features, the operating advantages, the provisions that make a pump easier to maintain, or service. You, too, will find it pays to standardize on Allis-Chalmers Power Plant Pumps.

ONE SOURCE FOR THE ENTIRE UNIT

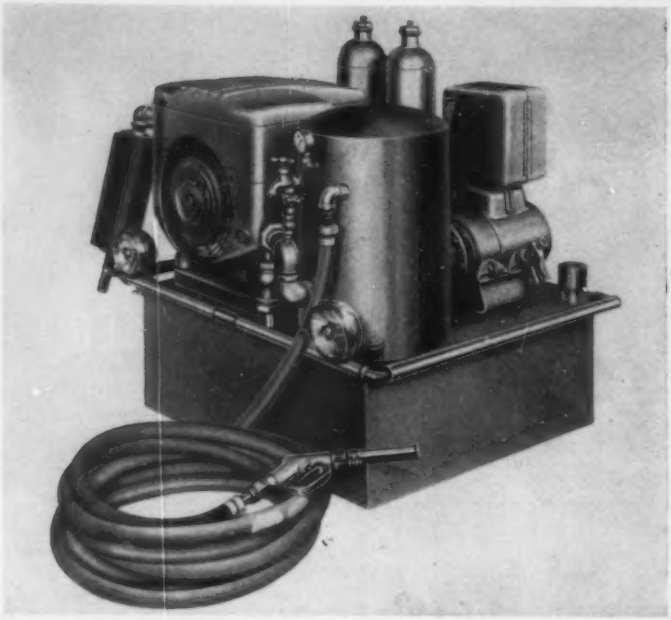
Allis-Chalmers can supply the complete unit of pump, motor and control — all of coordinated design and manufacture. And you get one responsibility, one reliable guarantee of satisfaction covering the whole unit. A-4407

For detailed information, call your A-C district Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for bulletin 08B7899.

ALLIS-CHALMERS

More EQUIPMENT NEWS

Begins on page 166

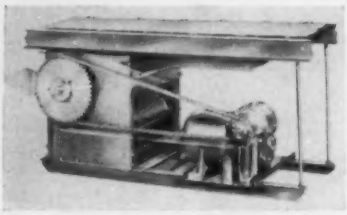


Portable fire-fighting unit is powered by 3500-w generating plant

1006 • Multi-purpose portable fire-fighting unit is powered by 3500-w, ac, *Onan* electric generating plant that provides power for pressure pump and floodlights, and also serves as emergency electric source for communications, electric tools, etc.

Unit utilizes a chemical solution called *Unox* that multiplies effectiveness of water from 10 to 20 times. This solution, which is UL approved, makes water more effective on class "A" and "B" fires. Manufacturer claims apparatus can extinguish a roaring diesel fire in 27 seconds. Unit is ideal for applications where both auxiliary fire-fighting equipment and emergency electric plants are priority items. Request "Versatile Power" folder from manufacturer, for complete information.

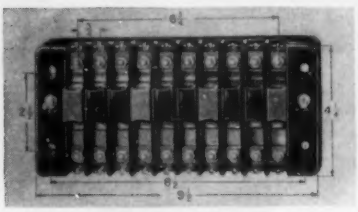
National Alarms Corporation, Lafayette, Louisiana



Center drive and take-up

1021 • Medium duty center drive and take-up can be combined with roller gravity conveyors to form belt or live roll conveyors. Unit is furnished with ½- to 1-hp gearhead motors with maximum effective pull of 300 lbs. Combination unit is designed to use regular 3-ply belting. Widths of 12 to 24 in., in 2-in. increments, available.

Lamson Corp, Syracuse, N. Y.

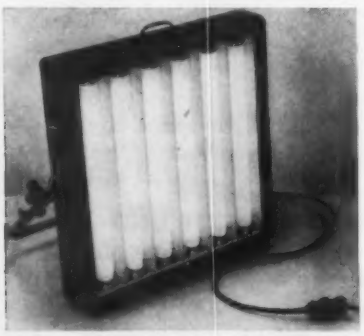


Meter test switch

1054 • Meter test switch operates on principle of fixed contacts and sliding link. Low contact resistance is assured by non-adjustable heavy spring whose pressure does not change with time. Complete details in manufacturer's bulletin 48.

Eastern Specialty Co, Philadelphia 40, Penna.

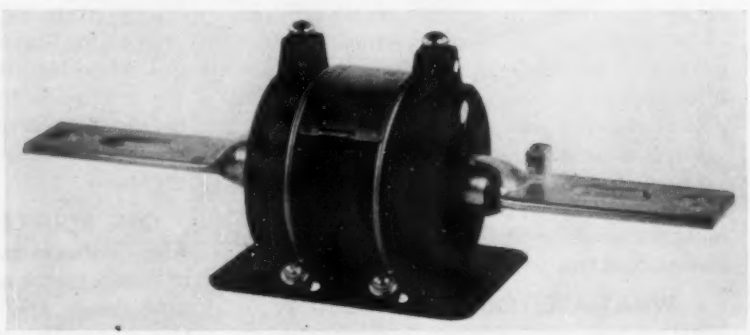
For more data on these items, use post cards p 175. Identify your request with item number.



Portable fluorescent light

1053 • Portable fluorescent floodlight uses 6 standard 15-w fluorescent tubes and is made for 110-v ac service. Unit is weatherproofed for indoor or outdoor use and contains separate switch for zero-weather starting. Heavy pressed-steel case is 21x21-in. Weighs only 33 lbs. UL approved. Complete information available from manufacturer.

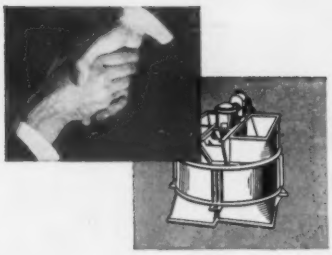
Electric Cord Co, 195 William St, New York 38, N. Y.

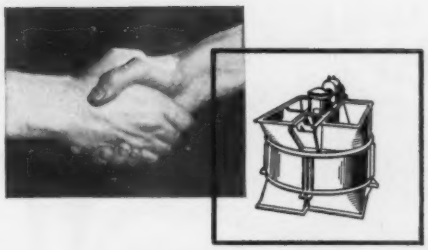


Miniature current transformer is suitable for 600-v circuits

1002 • Butyl-molded miniature current transformer, *JCA-O*, features both window-type and bar-primary construction. Unit is designed for operating meters and instruments and can be used on either single-phase two-wire or polyphase circuits. Rated at 600 v, it is suitable for use on any circuit of 600 v or below. Window-type unit is said to be ideal for operation over a bar-primary conductor on circuits up to its rated voltage. Two current ratings, 200:5 and 400:5 amps are available in both window and bar-primary models. Device is built to carry its rated current continuously with a 55 C ambient temperature without overheating. With a 30 C ambient temperature it will carry 200% rated current without exceeding the allowable 55 C rise.

General Electric Company, Schenectady 5, New York





Why your Ljungstroms are so efficient

—year after year

Air Preheater Corporation Field Engineers aim to visit every Ljungstrom Air Preheater in this country at least once a year. Their main objective is to increase availability and assure you a maximum return on your investment. They are always available for consultation.

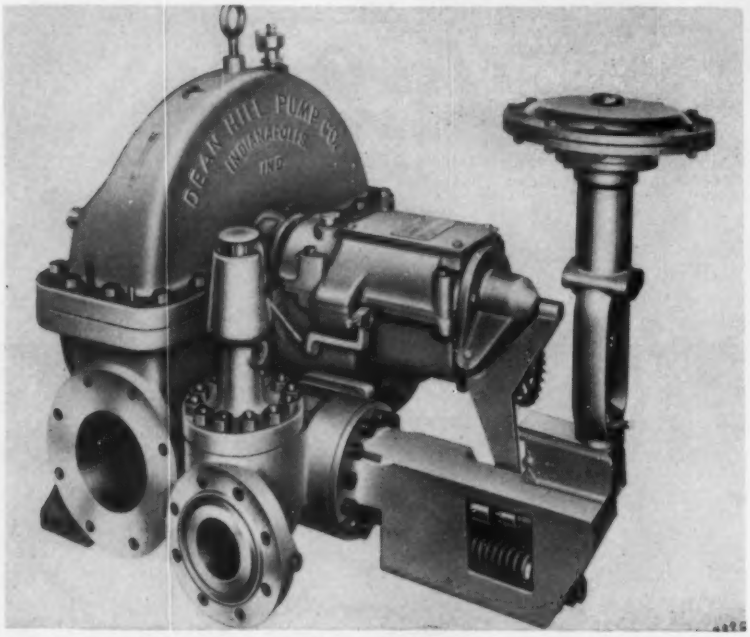
This is just another reason why the Ljungstrom Air Preheater is *the most economical heating surface on the modern boiler.*

THE AIR PREHEATER CORPORATION

60 East 42nd Street
New York 17, N. Y.

More EQUIPMENT NEWS

Begins on page 166



Turbines with pressure regulators designed for boiler feedwater use

1001 • Designed for boiler feedwater applications requiring precise automatic control of water pressure, regulators can be used with any of manufacturer's horizontal or vertical turbine models. Regulators are furnished with direct-acting or remote control. They can be arranged to maintain constant pump discharge pressure or constant differential over boiler pressure.

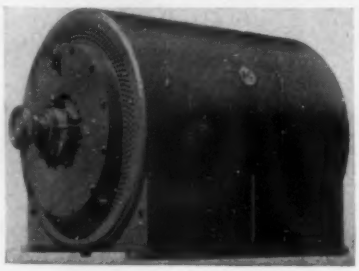
Regulator controls turbine speeds to normal rating, but above this point the turbine governor prevents overspeeding. Emergency trip valve remains independent. Request catalog 500 for complete information.

Dean Hill Pump Co, Dept 10, 4000 E 16th St, Indianapolis 7, Indiana

Explosion-proof motors

1019 • Manufacturer has added a 1250-hp, 2300-v, 1780-rpm unit, *Type ANZZ*, to its line of UL approved explosion-type motors. This represents the largest machine of its kind to gain UL approval. Units are modification of company's totally-enclosed, fan-cooled motor line with tube-type air-to-air heat exchangers. For industries where explosion-proof drives must be specified.

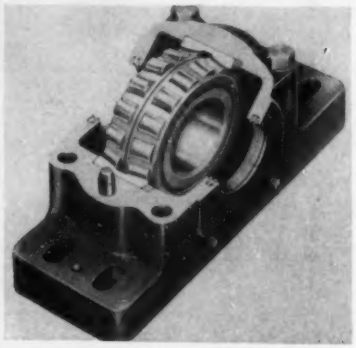
Allis-Chalmers Manufacturing Co, Milwaukee 1, Wisconsin



Magnetic disk brakes

1015 • Redesigned magnetic disk brake, *H-70*, is for use on rerated 3-20 hp motors and is available in maximum torque ratings of 10 to 105 lb-ft. Unit is designed to mount on frame sizes 213 through 286 and is up to 15/16 in. shorter than previous brakes. Spring set solenoid released brake is supplied for either horizontal or vertical motor mounting or independent floor mounting and is available with standard or dust-tight, waterproof enclosure.

Stearns Magnetic Inc, Milwaukee 46, Wisconsin



Press-fitted pillow blocks

1014 • Pillow blocks with heavy-duty self-aligning roller bearings for press fit on shafts are particularly adaptable for use in steel mills and other heavy industries. Press fit of bearings on machined shafts assures positive concentric mounting. *Series LPK7800F* "Mill Bearings" are available in bore size range of 3.1496 to 7.4803 in. Request book 2565A for full information.

Link-Belt Co, 307 N Michigan Ave, Chicago 1, Illinois

Reinforced conveyor belt

1052 • Ribbons of high tensile steel wire prevent accidental rips from running the length of a new type rubber conveyor belt.

According to manufacturer, wires running across the belt at 3-ft intervals act as barriers against rips when sharp objects penetrate belt, become jammed and slice the belt like a knife. Wire ribbons are positioned beneath the first fabric or cord ply and placed across the width of the belt. Wires are used in combination with longitudinal nylon breaker.

B F Goodrich, Akron, Ohio

For more data on these items, use post cards p 175. Identify your request with item number.

CHECK THESE TOO . . .

Packless proportioning pump . . p 180
Backward-curve blowers . . . . . p 182
Midget size dust collector . . . . . p 184
Float-type moisture trap . . . . . p 188
Corrosion-resistant bellows . . . . . p 192
Capacitive level indicator . . . . . p 196
Herringbone speed reducers . . . . p 198
Snap-on pipe insulation . . . . . p 200
Emergency lighting unit . . . . . p 202
Anti-seize thread compound . . . . p 206

R/M V-BELTS

If you use equipment powered by multiple V-belt drives, you can step up production efficiency — and lower costs — with R/M V-Belts. R/M Super-Power V-Belts and Condor V-Belts are the smoothest running V-Belts made because every part of their construction is precision-balanced. Straight sidewalls on these V-belts provide more grip, less slip, trouble-free performance. They last longer and do more work, too. On some drives you can count on 40% greater horsepower capacity with R/M Super-Power V-Belts as compared to regular V-belts . . . or do an equal job with fewer belts!

Whatever your particular V-belt needs, either R/M Super-Power or Condor is your assurance of longer belt life, improved performance and greater drive economy at your plant . . . "More Use per Dollar". Consult an R/M representative. Ask him about R/M Hose, Transmission, Conveyor Belts and other industrial rubber products for every use . . . in every industry.

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
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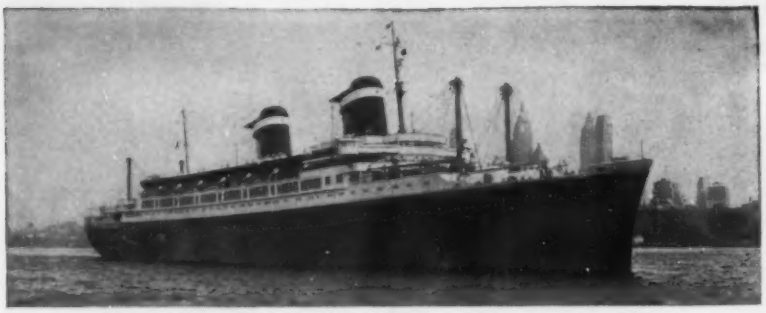
(Advertisement)

HALL INDUSTRIAL WATER REPORT

Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.

Volume 2 | OCTOBER 1954 | Number 5



Stops Scale in Seawater Evaporators

HAGEVAP LP* has been in continuous use in the large modern distillation plant on the S.S. *United States*, maintaining scale-free evaporators and assuring production of the highest quality fresh water, throughout her two years as queen of the North Atlantic passenger service.

These results on the S.S. *United States* confirm similar experience by United States Lines on the S.S. *America*, where HAGEVAP LP was introduced in the spring of 1949. In the intervening five years, the four multiple-effect salt-water evaporators on this liner have required almost no chemical or mechanical cleaning, while continuously and currently producing at better than rated capacity.

The two new luxury passenger liners of American Export Lines, the S.S. *Independence* and S.S. *Constitution*, entered the Mediterranean service in 1950 with HAGEVAP LP specified initially as the evaporator feed treatment. After four years' service, the huge seawater evaporators on these vessels are still free of scale deposits.

HAGEVAP LP feed treatment developed by Hall Laboratories and applied in the marine field by Bull and Roberts, Inc., is now the accepted standard for vacuum-type, single or multiple-effect seawater evaporators, and in most cases is specified by the owners or builders on new construction of passenger, cargo or tank vessels. In recent years, completely automatic feed treating equipment has been perfected, completing the full development of what amounts to push-button control of the problem of scale accumulations in seawater evaporators.

Wall Wrecker Whipped

Three times in two years an eastern Pennsylvania hospital had to tear out a wall in a new domitory building to replace corroded condensate return lines. Leaking lines had also stained ceilings and brickwork in other parts of the building, and the replacement of traps and unit heater coils was a constant expense.

Hall field engineer R. B. Carey recommended treatment of the system with a few ppm of Hagafilm,* which forms a thin film on the metal condensate lines.

In the three years since Hagafilm treatment was instituted, there has been no further failure of the condensate return system in any part of the building. Maintenance and replacement of traps and heater coils has ceased to be a problem.

*Registered Trademark

Hall Engineer to be Guest Speaker

R. K. Scott, head of the Identification Group at Hall Laboratories, will be a guest speaker at the X-Ray Diffraction School of the General Electric Company to be held in Milwaukee from September 27 to October 1. Subjects to be discussed will include the application of X-ray diffraction and fluorescence to chemistry, metallurgy, ceramics and other fields.

Mr. Scott will describe the work done by his group at Hall Laboratories, where X-ray diffraction is one of the means used to tell what substances are present in all sorts of samples of solid material. More than a hundred different constituents have been identified in deposits from boilers and other equipment in systems using water for all sorts of industrial operations.

Pamphlets Available

A series of pamphlets and booklets pointing out the practical importance of various phases of water conditioning has been published by Hall Laboratories.

Four of the pamphlets are now available on request.

1. What is Hall Laboratories?
2. Sources of Water
3. Boiler Water
4. Laying-up Equipment

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES, INC.—CONSULTANTS ON PROCUREMENT, TREATMENT, USE AND DISPOSAL OF INDUSTRIAL WATER

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AIR CONDITIONING, HEATING AND VENTILATING

1 **Industrial fans,** *Type XL,* with 11 to 60-in. inlet diameters. Static pressures to 18-in., volumes to 130,000 cfm. Four-page bulletin 702. Clarage Fan Co, Kalamazoo, Michigan.

2 **Exhaust fans.** Dimensions, capacities, applications in bulletin 600-B. Fort Worth Steel & Machy Co, Box 1038, Fort Worth 1, Tex.

3 **Blower wheel** designed for heating and air conditioning industry. Diagrams, construction data in 4-page bulletin. Mayne Products Co, 324 Harries Building, Dayton 2, Ohio.

★ **V-belt driven fans,** *MD Line.* Specs, performance charts, dimensions in bulletin MD-101. ★Request direct on company letterhead. Chicago Blower Corp, 9867 Pacific Ave, Franklin Park, Illinois.

4 **Backward-curve blower,** sizes 12½ to 86½-in. Self-limiting hp characteristics. Mechanical and engineering features in 4-page bulletin. Fan & Blower Div. The Peerless Electric Co, W Market St, Warren, Ohio.

5 **Steam diffuser** for direct open-tank water heating. Capacities to 150 gpm at 100 lbs steam and 100 F temperature rise. Cutaway, capacities on single-page bulletin. O'Brien Steam Specialty Co, Inc. PO Box 217, Eastwood Station, Syracuse 6, New York.

6 **Plate-type fin** and round tube core for engine cooling units and air conditioning heating and cooling functions. Two-page bulletin 5554. Young Radiator Co, Racine, Wisconsin.

BOILERS AND AUXILIARIES

7 **Packaged boilers,** *Type W-1, 2, 3,* have capacity range of 4100 to 30,000 lbs of steam per hr. Engineering data, photos, specs in 9-page bulletin WT-7. Wm Bros Boiler & Mfg Co, 1057 10th Ave SE, Minneapolis 14, Minnesota.

8 **Small boilers** available in 50 to 80 hp (15 to 150 psi steam, 30 psi hot water). Specs and drawings in 4-page bulletin AD-135. Cleaver-Brooks Co, 326 E Keefe Ave, Milwaukee 12, Wis.

9 **Gas-oil burners,** *Series CF.* Photos, specs, capacities and diagrams in 4-page bulletin R-230. Eclipse Fuel Engineering Co, 1001 Buchanan St, Rockford, Illinois.

10 **Industrial burners** and burner systems for gas, oil or combination. Selector table, photos, specs in 4-page bulletin. The Anthony Co, 47-33 5th St, Long Island City 1, N. Y.

ELECTRIC, MECHANICAL CONTROLS

11 **Temperature controller,** incorporates two complete systems for measuring and controlling two temperatures. Applications and control forms in 2-page bulletin 6430. Minneapolis-Honeywell Regulator Co, Industrial Div, Station 64, Wayne & Windrim Aves, Philadelphia 44, Pa.

12 **Switchgear.** Two, 24-page bulletins, 6004-A on low-voltage and 7004-B on high-voltage switchgear. Photos, diagrams, specs. Specify bulletin desired. I-T-E Circuit Breaker Co, 19th & Hamilton Sts, Philadelphia 30, Pa.

13 **Current limiting fuses,** *Type CLF,* for low voltage circuits where conventional fuses do not have adequate interrupting capacity. Eight-page bulletin 16-74. General Electric Co, Construction Materials Div, Bridgeport 2, Conn.

14 **Fuse reducers.** Applications, photos, specs in 2-page bulletin 8. Trico Fuse Mfg Co, N 5th at W Chambers, Milwaukee 12, Wisconsin.

15 **Control centers,** centralize electric motor control where motors are used in quantity. Specs, photos, selector charts in 16-page bulletin. Square D Co, Industrial Controller Div, 4041 Richards St, Milwaukee 12, Wisconsin.

16 **Temperature-monitoring systems.** Photos, applications, specs in 7-page bulletin 70. Thermo Electric Co, Inc, Saddle River Township, Rochelle Park Post Office, New Jersey.

(*Continued on page 234*)

HERE'S YOUR *Complete* STEAM PLANT

- One purchase, backed by undivided responsibility.
- Shipped completely assembled after factory tests to assure highest operating efficiency.
- More than 80% thermal efficiency guaranteed.
- 4-pass design provides 5 sq. ft. of heating surface per b.h.p.
- Induced draft fans which are built-in eliminate the need of an expensive chimney.
- Simple installation requires no special foundation.
- Clean, quiet operation.
- Heavy-duty, rugged construction assures long-lived dependability.
- Burner equipment to suit your fuel: gas, oil or both.
- 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i., or for hot water heating.
- For complete details, write today for catalog 600.

SUPERIOR STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES, Inc.

Factory: Emmaus, Pa.

Executive Offices: Times Building, Times Square, New York 18, N. Y.

George Edwards' Scrapbook

A large Eastern oil refinery finds production is up 15% since they painted drab old equipment all colors of the rainbow. One tank is now chartreuse, pipes around it are a vivid blue, building daffodil yellow, and towers a chalk white with bases of Kelly green.

Furnace for heating crude oil is lavender. Before, furnaces were painted black to conceal spillage. With light colors, men are more careful. Streaks show up leaks—they are repaired at once. Everyone takes pride in preventing spills; they keep an eye on each other.

Who selects the colors? Why, employes who work in the area. Electricians decided on aqua blue over white for their shop—after casting many votes. Point is, since they work there, management lets them decide. Would your wife be happy if you painted rooms in your home the colors *you* want?

Also, old greasy floors of the refinery are being tiled because men hate to track dirt around. As soon as a floor is tiled, streets around the building are paved to keep tile clean. Now that refinery is clean, men stay on the job longer, work harder because environment is more pleasant. This idea could pay off big in many power plants and factories that still remind me of something out of Dante's *Inferno*.

* * *

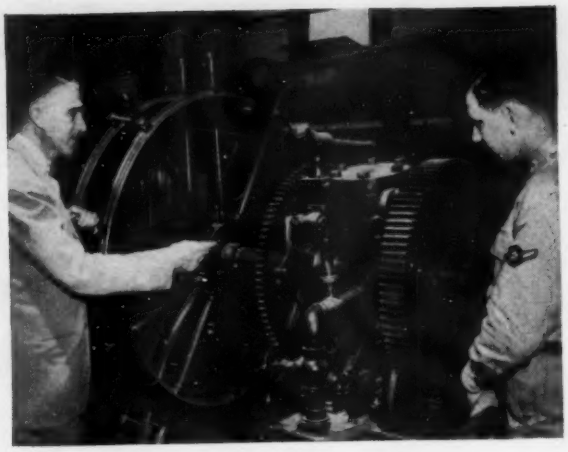
The man who does not do more work than he's paid for isn't worth what he gets. —ABRAHAM LINCOLN

* * *

At long last, the first solar battery has been made by the Bell Telephone Laboratories. Strips of treated silicon, about the size and thickness of razor blades, collect sunlight, which liberates electrons from silicon. Each strip delivers current at half a volt. Strips can be connected in series for desired voltage. Chemical or other batteries may be used to store electricity from solar batteries on sunless days, during the night.

In bright sunlight, a square yard of strips delivers 50 watts. About 6% of the energy in light striking the strips is converted into electricity. The sun sends our earth over a thousand trillion kilowatt-hours a day. So you see that some form of solar battery may postpone a crisis of running out of oil, then coal, in the indefinite future.

It would certainly be interesting to visit a power plant, say, in 2954, a thousand years from now, to see what a power engineer's job will be like. Any ideas?



DID YOU KNOW that power steering is nearly 100 years old? A distant ancestor of the power-aided steering on today's new cars is this steam steering engine of 1858. Frederick E Sickles, who deserves to be better known for his fine engineering work, installed this equipment on the steamship *Augusta* plying between Savannah, Ga., and Fernandina, Fla.

In the photo, Frank Taylor of the Smithsonian Institution, Washington, D. C., is showing a visiting airman how the steering wheel operates the valves of the engine, which turned the ship's rudder.

Sickles also invented a successful variable drop cutoff valve gear, patented in 1841, but his work was overshadowed by George H Corliss' success. Later, he applied the governor to the drop cutoff gear.

History repeats itself, but some people never learn. For example, the Pilgrim Fathers set up a communist system in Massachusetts. Each person contributed to a common storehouse. But when the harvest came, there wasn't enough grain to go around because everyone let George do the work. The people complained they were too weak from want of food to work—they stole from each other—and things got pretty rough.

Governor Bradford finally put everyone on his own. As he wrote in his journal, "This had a very good success; for it made all hands very industrious, and much more corn was planted than otherwise would have been. Now there is more corn than we can use, and we save a great deal of trouble and everyone is better contented."

That was in 1623, yet today there are many people who don't realize that none of the Utopian ideas tried for thousands of years has produced so much for so many as our practical American competitive system. I'd sure hate to have to make a new start in some other country. How about you?

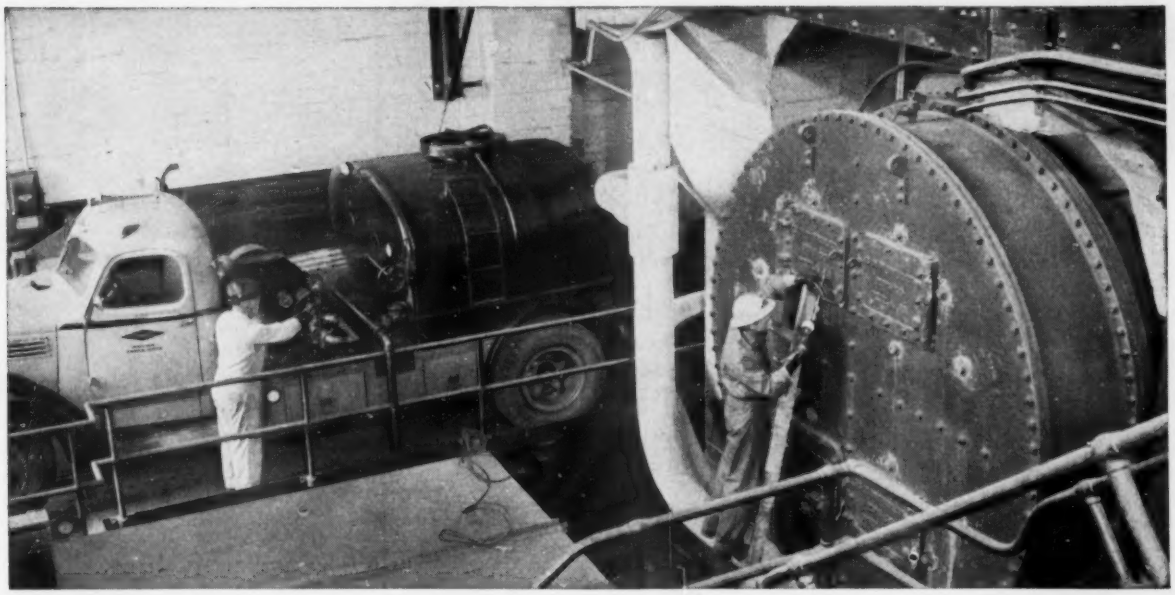
* * *

Be careful of another's feeling. Wit and humor at the other fellow's expense are rarely worth the effort, and may hurt where least expected—that's my experience.

George Edwards
Engineer

CHEMICAL CLEANING SAVED 400 TONS OF COAL PER YEAR

Fly ash, soot and carbonate deposits removed from condenser by Dowell; vacuum increased



Fly ash and carbonate deposits on the water side of an 800-KW turbo surface condenser had reduced vacuum from a normal 28″ to 24″. The temperature of the water leaving the condenser had dropped from 95°F. to 85°F.

These deposits were removed by Dowell Service with specially prepared liquid solvents. Result: the condenser was restored to its normal operating efficiency. The steam requirement was reduced by 2.5 pounds per kilowatt hour. On the basis of 8,000 hours of yearly operation, the plant engineer calculated a saving of at least 400 tons of coal per year.

Dowell chemical cleaning methods can be used on hundreds of different kinds of industrial equipment. Engineers especially trained for this kind of work do the job for you. They apply solvents according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Dowell liquid solvents can go wherever steam or water will flow, reaching places inaccessible to other cleaning methods. Scaffolding is unnecessary. Dismantling and downtime are kept to a minimum.

A call for Dowell Service will bring experienced personnel to your plant within a few hours with all necessary chemicals, pump trucks and control equipment. For complete information and estimates on the cleaning of your equipment, contact the nearest Dowell office, or write directly to Tulsa, Dept. J-23.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
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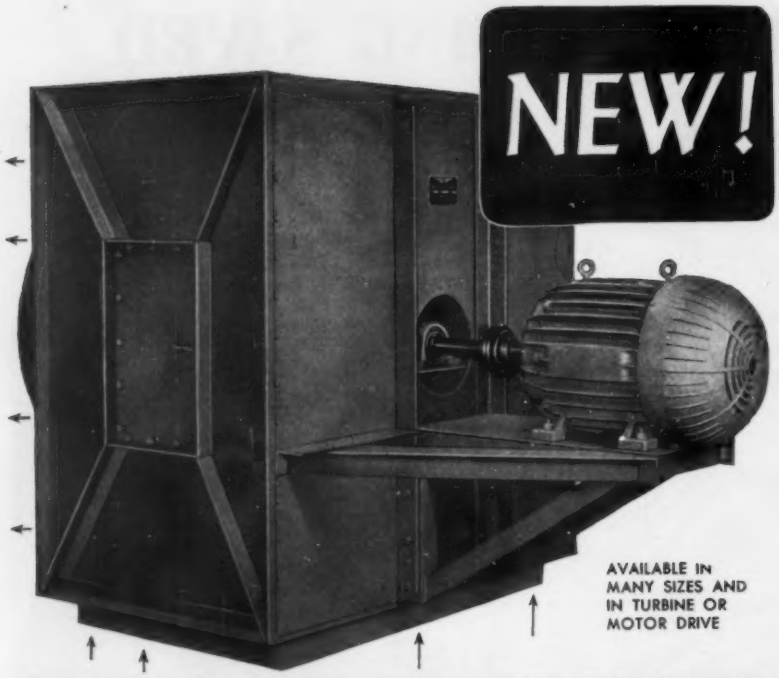


WING PACKAGE DRAFT INDUCER

FOR POWER PLANTS

MOTOR AND FAN DESIGNED AS ONE COMPLETE REMOVABLE UNIT

MAKES INSTALLATION EASIER

FACILITATES INSPECTION AND MAINTENANCE

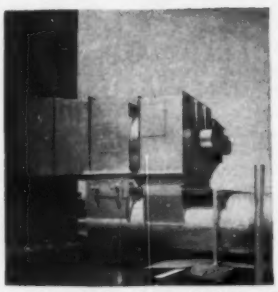
SAVES SPACE

ELIMINATES WATER COOLING OF BEARINGS

INTERCHANGEABLE INLETS—TOP, BOTTOM OR SIDES

NO LUBRICATION REQUIRED —BEARINGS PRE-SEALED

Write for complete details



WING PACKAGE DRAFT INDUCER AT PLANT OF WELCH GRAPE JUICE CO.

L. J. Wing Mfg. Co.

50 Vreeland Mills Road
Linden, New Jersey

Factories: Linden, N. J. and Montreal, Canada

SEVENTY-FIVE YEARS AGO

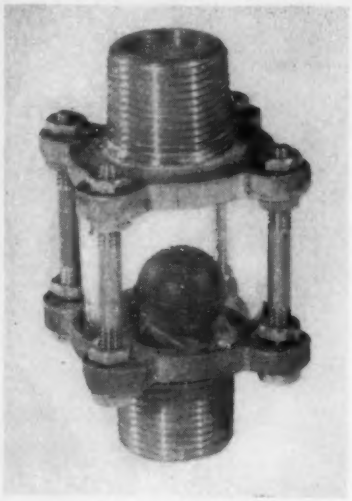
In 1879, L. J. Wing, a resourceful inventor, founded the company that is now celebrating its 75th anniversary. Three years before, when Mr. Wing invented the Disc Fan that bore his name, General George A. Custer (above) and 276 soldiers of the 7th Cavalry were massacred at the Battle of the Little Big Horn in Montana, by Indian tribes led by Sitting Bull, the prophet.

OUR 75TH YEAR 1879

Wing

More EQUIPMENT NEWS

Begins on page 166



Sight flow indicator

1025 • Ball type indicator is recommended for use with water having a high silt content. Installed in piping for vertical upward flow, displacement of Neoprene ball indicates flow. Available in bronze or cast iron, in sizes ⅜ to 2 in. and in male and female connections. Data sheet 142 available.

Stets Company, 1440 Broadway, New York 18, New York

For more data on these items, use post cards p 175. Identify your request with item number.

Packless proportioning pump

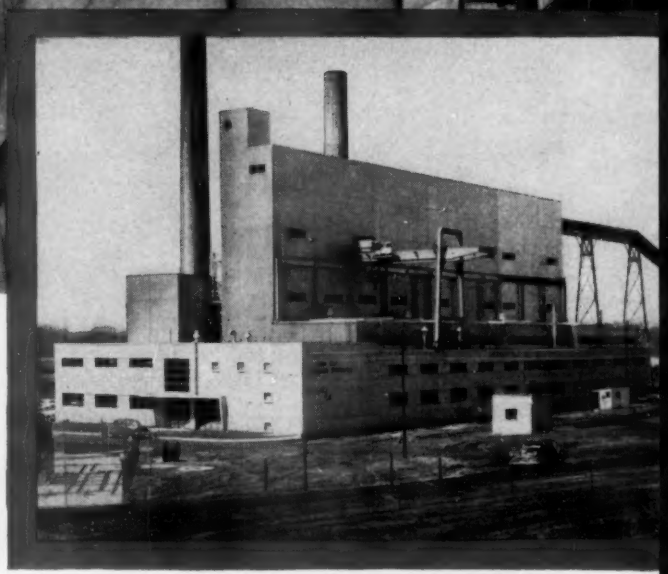
1016 • Proportioning pump with no packing, high speed valves and pulse free flow is claimed to meter quantities from 5 cc to 6 gals per hr per feed, dependent somewhat on material being handled. Standard speeds range from 27 to 900 strokes per min and at higher speeds and capacities, flow is continuous for all practical purposes. Gases and vapors are vented automatically. Standard units will develop pressures to 2500 psig. Full details from manufacturer.

Hills-McCanna Co, 3025 N Western Ave, Chicago 18, Illinois

Submersible turbine pumps

1035 • Units are designed to meet demands for larger volumes of water than are obtainable with conventional types of water systems. Capacities range from 600 to more than 7000 gph. Entire pumping unit

On-the-spot help and advice is part of the job for every Standard Oil lubrication specialist. Here Chief Operator G. C. Barlow and Standard's R. R. Spargo examine color and clarity of NONPAREIL during regular periodic check-up.



"We picked the only oil with a turbine life-time guarantee!"

NONPAREIL
TRADE MARK
Turbine Oil

STANDARD

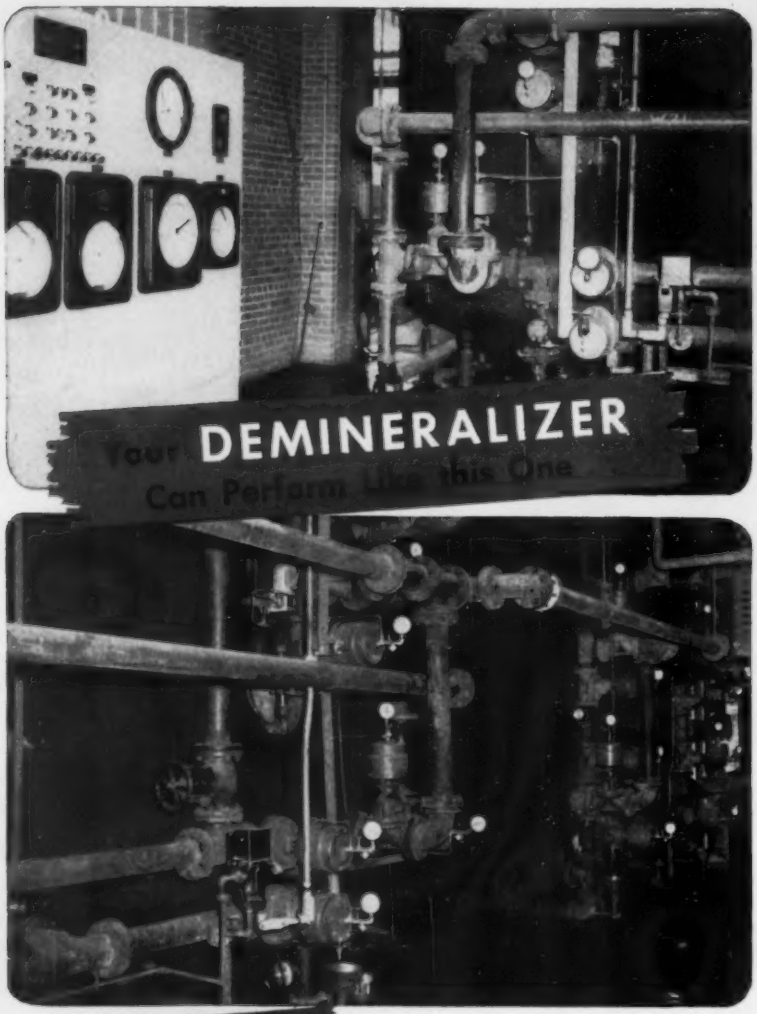
■ "When our new Power Plant was planned, your turbine oil guarantee impressed all concerned at the Corn Belt Power Cooperative at Humboldt, Iowa," says Chief Operator G. C. Barlow. "Only Standard offered a guarantee on turbine oil for the life of the turbine—so we chose Standard's NONPAREIL Turbine Oil—and we've been completely satisfied since."

Specifically, Standard guarantees that the acidity of NONPAREIL Turbine Oil will never exceed a neutralization number of 0.15 KOH/gm. This means an absence of sludge and deposits in governors and filters. The whole system stays clean. The oil never needs to be removed for treating or cleaning.

Corn Belt's first three turbines were initially filled with NONPAREIL Turbine Oil in 1950 and 1951. Since then periodic checks have shown that the neutralization number has never exceeded 0.04 KOH/gm. The turbines have operated perfectly without *any* cleaning or changing of oil. Naturally, when a fourth turbine was recently added it too was filled with NONPAREIL.

NONPAREIL has been making records like this in turbines large and small for more than 25 years. For this kind of guaranteed superior lubrication in *your* plant's turbines—new or old—fill with NONPAREIL. A Standard Oil lubrication specialist will be happy to show you the facts and data on NONPAREIL's history in installations similar to yours. Call your nearest Standard Oil office or write: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (*Indiana*)



with Nalcite*

HIGH CAPACITY
HIGH TEMPERATURE
ION EXCHANGE
RESINS

500 gallons per minute of clarified Missouri River water are completely deionized for 100% make-up to a 1250 psig boiler by this Nalcite-charged unit at a large Midwestern utility. Whether your water conditioning problem is large or small, Nalcite HCR cation exchange resin, together with either Nalcite SAR or SBR anion exchanger gives you performance that means longer on-line operation, with removal of both strong and weak acids including silica.

Full information on Nalcite Ion Exchange Materials is yours for the asking. Write today.

*Reg. Trademark of the Dow Chemical Company

Nalco®

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

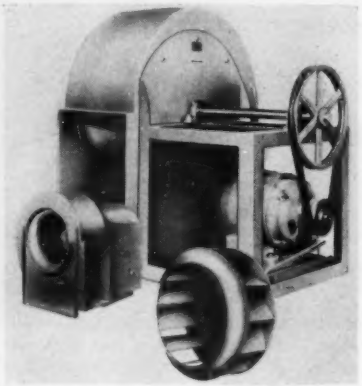
PRODUCTS • *When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.*

More EQUIPMENT NEWS

Begins on page 166

is made of corrosion-resistant materials for operating completely submerged in the well water. Pump never needs priming. Manufacturer claims it is practically noiseless in operation and requires minimum of power. Moving parts of pump are water cooled and water lubricated. As tank and control may be located away from well and service line placed below ground, no pump house is required. Impellers are low thrust type, accurately positioned in each bowl or diffuser, and require no adjustment. Request bulletin 6710-20 for full information.

The Deming Company,
547 Broadway, Salem, Ohio

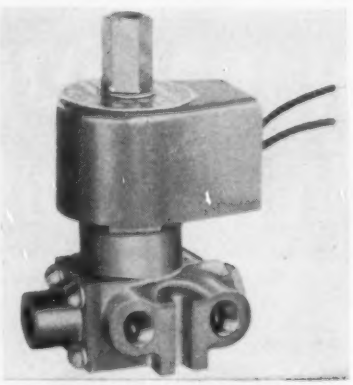


Backward-curve blowers

1011 • New backward curve blowers particularly suited for electronic field, are being manufactured in sizes from 12¼ to 36½ in. Unit has self-limiting horsepower characteristics and meets all performance standards and requirements, according to manufacturer. Top feature of the blower is the dynamically balanced wheel designed with a matching spun cone. Unit is availabel with either direct connected or belt drive.

Peerless Electric Co, Warren, Ohio

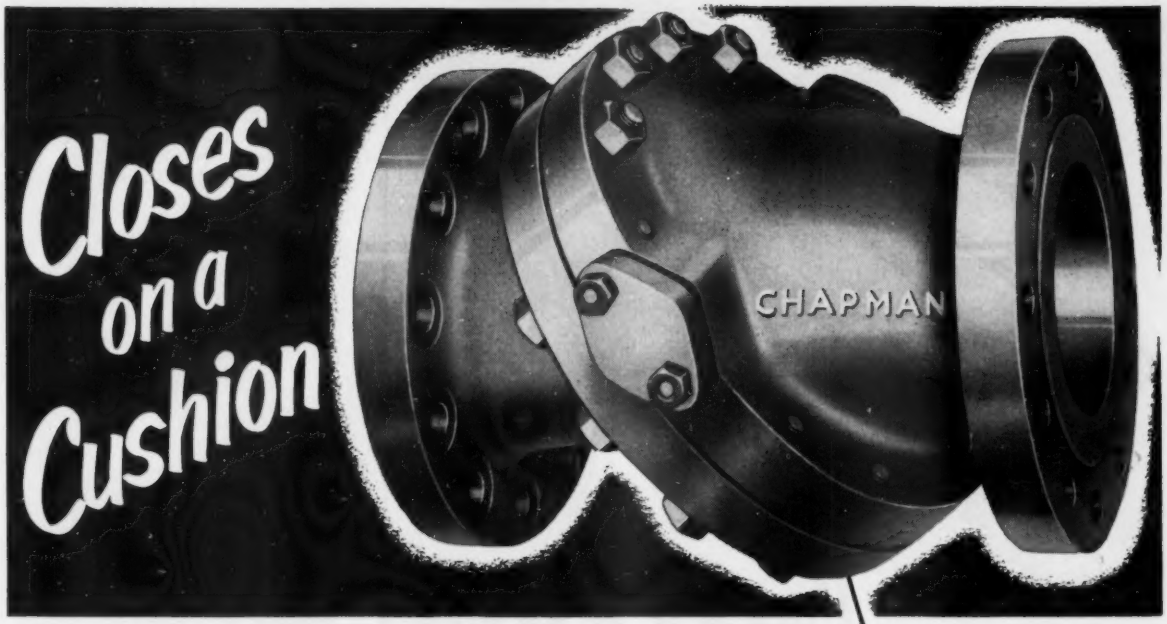
For more data on these items, use post cards p 175. Identify your request with item number.



Midget solenoid valves

1008 • Compact 4-way solenoid valve is 4 7/16-in. high with overall length under 3 in. and depth of 2 in. Permissible pressures range from 10 to 125 lbs for ac and to 50 lbs for dc. Pipe size is ¼ in., orifice

Chapman's Tilting Disc Check Valve

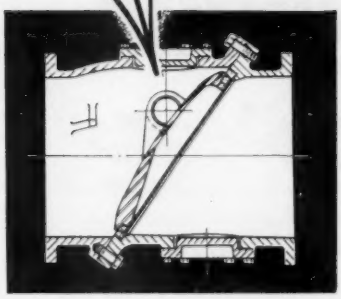


...for low cost, slam-free operation

Balanced pressures *cushion* the movement of the disc in Chapman's Tilting Disc Check Valve. The valve closes quickly but quietly, in all but unusual piping arrangements. There's no slamming to damage pipe-line joints or the valve itself. And *drop-tight* closure eliminates sliding wear on the disc and seat.

In the open position, the "airfoil" designed disc rides firmly against stops, without swinging or fluttering. That's why the hardened extra-large hinge pins give extremely long wear. And the absence of turbulence is one reason why head loss through Chapman's Tilting Disc Check Valve is lower than through any other type of check valve.

Low head loss, increased wear resistance and freedom from destructive slamming make Chapman's Tilting Disc Check Valves unbeatable for almost every installation. Write for Catalog No. 30 today.



Here's why
CHAPMAN Tilting Disc Check Valves
***Keep Quiet* All Their Lives**

This specially designed "airfoil" disc balances perfectly in open position . . . then drops easily to closed position (cushioned by the flow). No jarring or slamming, in usual pipe-layouts. Write for bulletin.

THE CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.

Air valve for one-man operation.

ROTOJET®
Junior TUBE CLEANERS

ELLIOTT COMPANY-ROTO DIVISION

153 SUSSEX AVE. • NEWARK 1, N. J.

More EQUIPMENT NEWS

Begins on page 166

diameters are 1/16-in. inlet, 3/32-in. exhaust. Power consumption is 10 w.

Valve is designed for handling air, water, light oil and other non-corrosive gases and liquids at temperatures to 212 F. Units are available with standard, watertight or explosion-proof solenoids. Bulletin 8345.

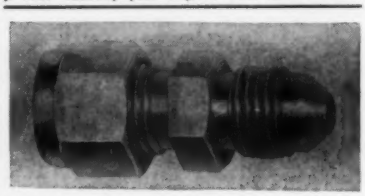
Automatic Switch Company, 391 Lakeside Ave, Orange, N. J.

Stainless steel solenoid valve

1034 • Stainless steel solenoid valve for extremely high pressures is offered in ½- and ¾-in. pipe sizes, rated to 2500 psi, and 1½-in. pipe size, rated at 3000 psi. Piston rings compensate for expansion under heat and eliminate sticking. Valves are available for normally open and normally closed operation with bubble tight pilot valve feature. Explosion proof housing optional for hazardous atmospheres.

Atkomatic Valve Company, Dept S258, 545 Abbott St, Indianapolis 25, Ind.

For more data on these items, use post cards p 173. Identify your request with item number.



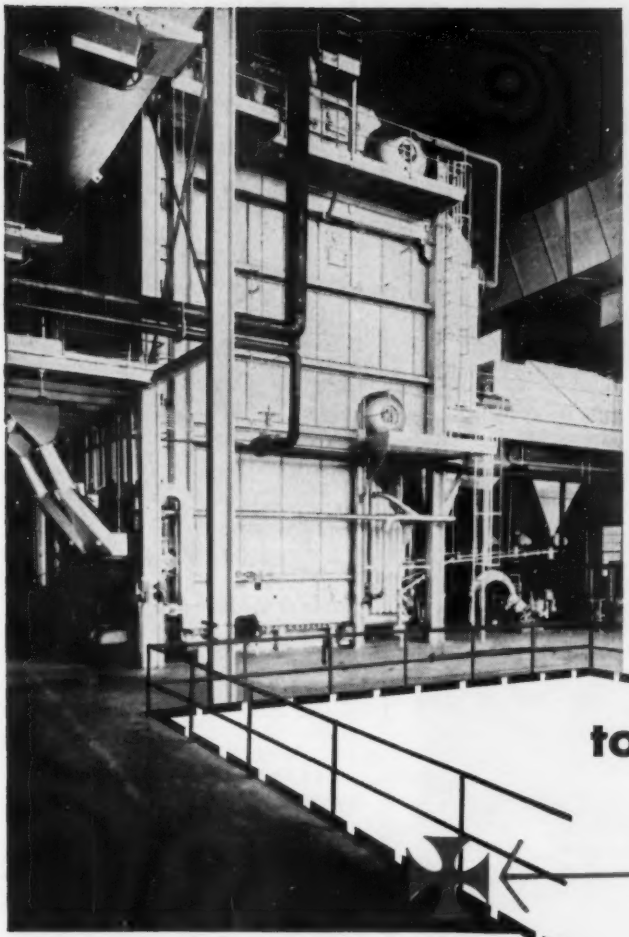
Flare connectors

1055 • Unit makes switching from flare fittings to *Swagelok* tube fittings easy and practical for testing or permanent installations. Threaded end conforms to AN standards. Opposite end incorporates *Swagelok* principle of design which results in torque-free, leak-proof seals at all connections, according to manufacturer. Available in ⅛ to 1-in. sizes.

Crawford Fitting Co, 884 E 140th St, Cleveland 10, Ohio

Midget-size dust collector

1056 • Compact self-contained unit for control of dusts from individual machines or those remotely located from a general dust control system, is rated at 553 cfm on a 4-in. inlet. Dust centrifuged out by cyclone separator is retained in compartment which



another Detroit RotoGrate Stoker for Manitowoc

Wisconsin

to be installed here

Manitowoc Municipal Power Plant

R. E. Cannard, General Manager and Chief Engineer

In 1950 the Public Utilities Commission of the City of Manitowoc installed their first Detroit RotoGrate Stoker with a 175,000 pound per hour Wickes steam generator.

This installation has been so successful that the Utilities Commission has ordered a second Detroit RotoGrate Stoker to fire another Wickes steam generator of 200,000 pound per hour capacity to be installed adjacent to the first unit. Either Ohio or Indiana coal is used.

Detroit RotoGrate Stoker is an advanced design of spreader stoker with grates that move slowly forward continuously discharging ash at the front. Burns a wide range of Bituminous coals or Lignite without special preparation, also hogged wood or bark and other refuse fuels.

Efficiency and burning rates are high with either steady or rapidly fluctuating loads. Parasite power is low. Combustible content of ash is usually less than 2%.

Get complete data on Detroit RotoGrate Stokers. Recommendations and Bulletins supplied without obligation.

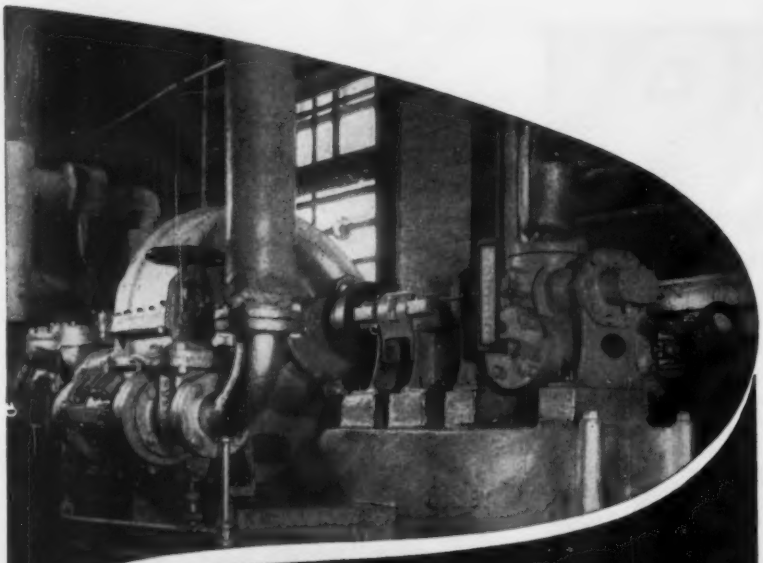
6852

DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY

General Motors Building—Detroit 2, Michigan

District Offices in Principal Cities • Works at Monroe, Michigan



THIS

WARREN-QUIMBY

SCREW PUMP

"became of age" in 1950

at American Cyanamid Warner's Plant

Linden, N. J.

Also, it has a twin brother there too, both installed in 1929 and *no repairs on either up to 1951.*

These turbine driven No. 3¼ Warren-Quimby Screw Pumps supply Bunker "C" Fuel Oil at 90°F. to the burners in the Linden Power Plant, which generates steam for power and processing. They are driven by 25 hp 1300—1495 r.p.m. non-condensing turbines; capacity 58 g.p.m. at 1300 r.p.m. against discharge pressure of 250 psig, with suction lift of 8 feet.

POWER PLANT OR PROCESSING, SPECIFY: WARREN QUIMBY PUMPS

G-2

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

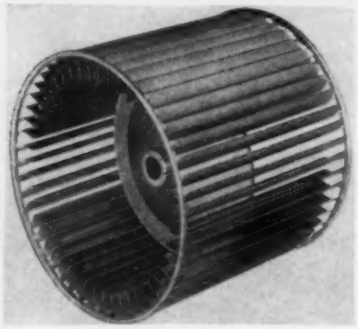
Warren, Massachusetts

More EQUIPMENT NEWS

Begins on page 166

comprises entire base of collector. Cleaned air, together with any toxic gases, smoke and obnoxious odors, is exhausted outdoors through 6-in. diameter exhaust connection at top of cyclone.

Aget-Detroit Co, Ann Arbor, Mich.

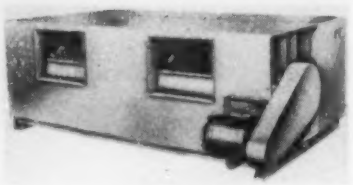


Durable blower wheel

1038 • Simplified blower wheel, for the heating and air conditioning industry, is said to feature more air per dollar and quieter operation. Built with only eight parts, wheel requires just two stamped strips of blades. One blade section is superimposed upon the other, interlocked and welded into one unit.

Mayne Products Company, 324 Harries Bldg, Dayton 2, Ohio

For more data on these items, use post cards p 175. Identify your request with item number.



Air conditioning unit

1057 • A line of air conditioners in ten different sizes from 600 to 29,000 cfm is offered in both horizontal and vertical models. It is possible to include or omit any of the six air conditioning phases without interfering with the basic design. One of the features is a sloping drain pan under the entire unit that assures positive drainage of condensate. The variety of coils available permits all practical combinations of heating, cooling, humidification and dehumidification. Send for bulletin DS-303.

The Trane Co, La Crosse, Wis.

Rubber-plastic valve body

1031 • Lightweight rubber-plastic valve body with a 3-in. diameter makes possible completely corrosion-resistant and non-contaminating piping systems of greater capac-

A. P. GREEN

Plastic and Castable Monolithic Linings Give Higher Operating Efficiency . . . Lower Maintenance Costs in Watertube Boilers

Monolithic refractory linings, properly installed, give better combustion efficiency and longer service life than any other type lining.

During operation, the sections of a furnace are subjected to different conditions. Each A. P. Green product has been developed to meet the service requirements of the zone for which it is specified. A. P. Green plastic and castable furnace linings installed under the supervision of trained personnel give you the full benefit of monolithic construction, plus the advantages of "zone-rated" materials.

SUPER HYBOND is a special super duty plastic that develops high strength throughout its entire thickness . . . regardless of furnace operating temperature. It is ideal for use in spreader stoker arches and piers, behind waterwall tubes, and as a seal around tubes where they pass through the wall.

SUPER-PLASTIC . . . a super duty plastic designed for use where operating conditions are unusually severe. Gives excellent service in complete monolithic linings, side walls in furnace area, flat suspended arches and spreader stoker arches. Patching and repairing firebrick or plastic linings with SUPER-PLASTIC results in longer, more efficient service.

PLASTIC QUIK-PAK . . . a high duty plastic refractory which combines refractoriness, low shrinkage and hot load bearing strength. It is used in constructing monolithic side walls and in patching those portions of watertube boiler linings which do not require super duty plastic.

KAST-SET is a high quality refractory castable which develops a strong hydraulic bond without application of heat. Recommended for convection sections of watertube boilers, baffles, waterwall backing, linings for stacks, breechings, flues, and ducts.

KAST-O-LITE is a lightweight, insulating castable refractory for temperatures up to 2500° F. Used for monolithic linings in convection sections of boilers. Reduces heat loss. Insures closer temperature distribution and control.

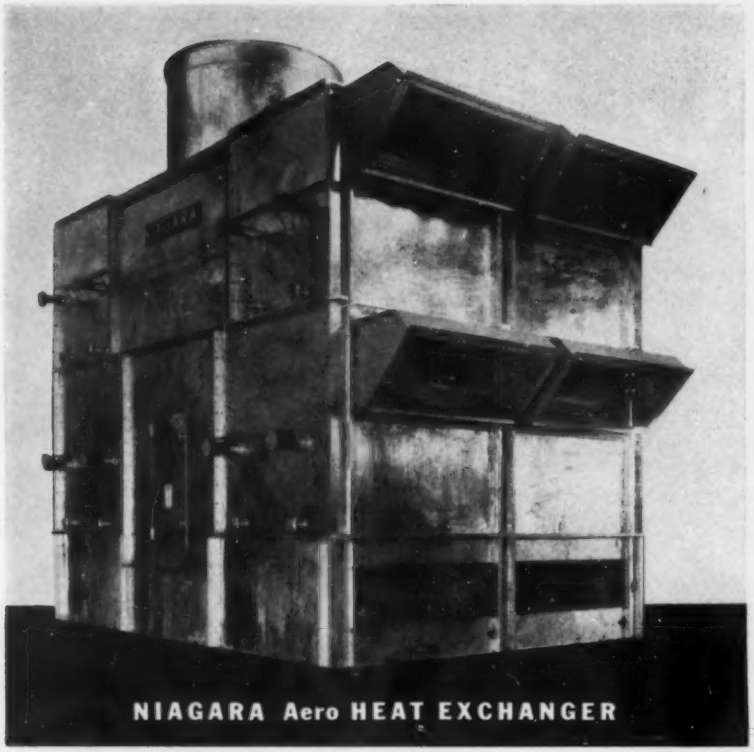
For properly engineered monolithic linings call your A. P. Green distributor —he's listed in the yellow pages of your telephone directory.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

In Canada:
A. P. Green Fire Brick Company, Ltd.
Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD



NIAGARA Aero HEAT EXCHANGER

Thirty Million B.T.U. CAPACITY

with Precise Control of Temperature in Cooling

The NIAGARA Aero HEAT EXCHANGER cools liquids and gases by evaporative cooling with atmospheric air, removing the heat at the rate of input, controlling temperature precisely. You save 95% of cost of cooling water; you make great savings in pumping, piping, power; quickly recover your installation cost.

You can cool and hold accurately the temperature of all fluids, air and gases, water, oils, solutions, chemical intermediates, coolants for mechanical, electrical and thermal processes. You obtain closed system cooling free from dirt. You solve all the problems of water availability, quality or temperature.

In CHEMICAL PROCESSES this is successfully used in cooling liquids and gases, chemical reactions, condensing distillations and reflux cooling.

Write for complete information; ask for Bulletins 120 and 124. Address Dept. P.

NIAGARA BLOWER COMPANY

405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of United States and Canada

More EQUIPMENT NEWS

Begins on page 166

ity than ever before. Valve body is made of styrene copolymer called *Uscolite*. Company also manufactures a complete line of 3 and 4-in. pipe fittings made of the same material. Valve and pipe fittings are of one-piece, homogeneously-molded construction, having no welds or joints at points of stress. Working pressures range to 150 psi and temperatures to 170 F.

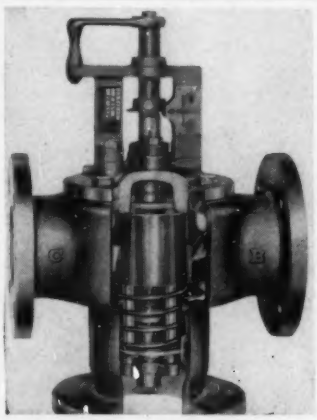
United States Rubber Company, Rockefeller Center, New York, N. Y.

Float-type moisture trap

1017 • Float-type moisture trap, *No. 81*, is designed as a low cost method of draining moisture and condensate continuously and automatically from piping systems, *Hi-eF* purifiers and other equipment that handles air, gas or steam. Suitable for operating pressures to 200 psig, unit is furnished with ½ or ¾-in. connections. Trap consists of stainless steel valve and seat, lever, and copper hide float inside cast semi-steel case. A stainless steel float can be furnished. Request drawing S-1555.

The V D Anderson Company, 1935 W 96th St, Cleveland 2, Ohio

For more data on these items, use post cards p 175. Identify your request with item number.



Temperature regulators

1030 • Temperature regulators containing a new-type thermal element are designed for use on internal combustion engines. They have three-way valves. Instead of the usual liquid- or gas-filled thermal element, these units contain a *Power-Pill* thermal element

For a wide range of uses

Fig. 30-0F 300 lb. at 875° F
For 150 lb. at 500° F.
specify Fig. 15-0F.

STOCKHAM STEEL GATE VALVES are rugged

Although rated at 150 pounds at 500°F. and 300 pounds at 875°F, these valves give you high performance under a wide range of temperatures and pressures. Many trim combinations can be furnished to meet the service requirements of water, steam, oil, gas, chemicals and vapors under normal, corrosive, erosive and oxidative conditions. With straight through port design, there are no pockets to cause turbulence. For full open-close operation, these valves allow maximum flow, with minimum friction and pressure loss.

For detailed information on the many more advantages of these newly engineered valves write for Stockham Steel Valve Catalog

VALVES: Bronze • Iron Body • Steel
Wedgeplug Dry Plug

FITTINGS: Cast Iron Screwed, Flanged
Cast Iron Drainage • Malleable Fittings & Unions

STOCKHAM VALVES & FITTINGS

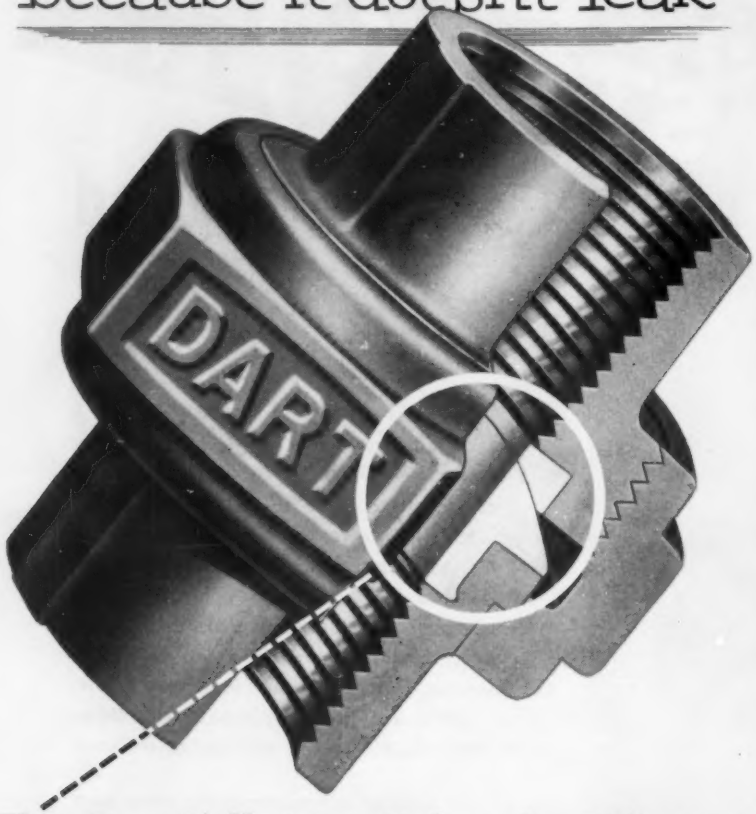
GENERAL OFFICES AND PLANT • BIRMINGHAM 2, ALABAMA

Warehouse Stocks and Sales Services Strategically Located

DISTRIBUTED THROUGH WHOLESALERS

Piper's Pet

because it doesn't leak



This True Ball Joint Makes the Difference

Yes, Dart Unions are the choice of boss pipers, master mechanics, foremen and superintendents not only because they *do the job* but because they go on easily — and can be used over and over again. Result: no leaks, no drip, no time or money wasted. Make them *your* buy!

QUICK FACTS

- *Leakproof* because precision machined to a true ball joint and spherically ground
- *Bronze alloy seats* are extra wide, resist pitting and corrosion
- *Shoulders* are heavy — can take abuse. (Severe wrenching is never needed, however)
- Practically indestructible *Nut and Body* . . . of air-refined, high test malleable iron

DART

UNIONS

DART UNION COMPANY • PROVIDENCE 5, RHODE ISLAND

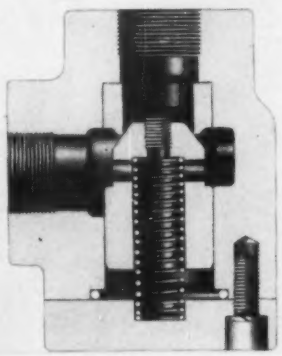
The Fairbanks Co. — Distributors: Boston • New York • Pittsburgh • Rome, Ga.

More EQUIPMENT NEWS

Begins on page 166

charged with a solid, wax-like compound. When subjected to heat this compound imprisoned in the *Power-Pill* unit melts and expands, generating an extremely powerful force by comparison with older thermostatic units. Heated liquid returns to solid state upon cooling. Regulators are smaller in size and lower in cost than existing units for similar applications, the company states. Regulators contain from one to four *Power-Pill* units, depending on valve size, which ranges from 2 to 6 in.

Fulton Sylphon Division, Robertshaw-Fulton Controls Co, Box 400, Knoxville, Tennessee



Hydraulic check valve

1059 • This 3000 psi valve allows free flow in one direction, prevents flow in opposite direction. Valve may be secured with pipe thread or flange connection, spring or pilot operated. Sizes ¼ to 1½ in.

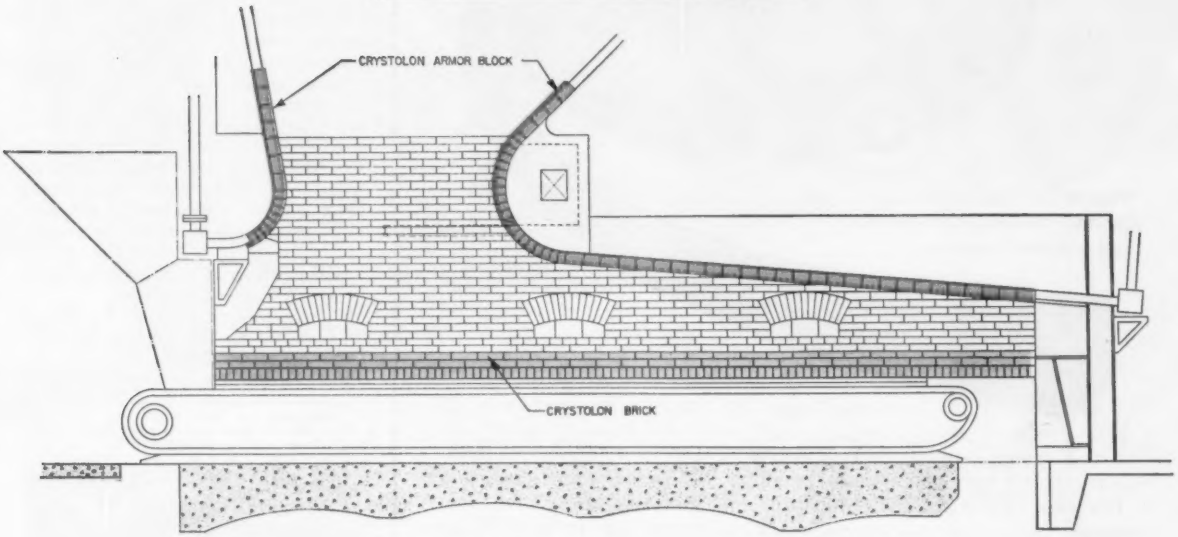
Rivett Lathe & Grinder, Inc, Brighton 35, Boston, Mass.

For more data on these items, use post cards p 175. Identify your request with item number.

Vacuum tube voltmeter

1027 • Portable, true peak reading vacuum tube voltmeter is capable of measuring pulses with very short cycles. Designed to operate over a wide bandwidth—50 cps to over 100 mc—unit may be used to measure positive peak, negative peak or the peak to peak voltage of a waveform. Voltage range of *Model VM-1* is 100 v full scale, with multipliers available to 30 kv, designed to permit rapid selection of voltage ranges. Actual measuring elements are housed in a

CRYSTOLON* Refractories give vital protection — *two ways*



Norton brick and armor block provide two money-saving Rx's — reduce abrasion and safeguard water tubes

This diagram of a chain grate, stoker fired boiler shows how abrasion of the setting by moving fuel has been cut to a minimum. Three to five courses of CRYSTOLON brick at and above grate level are all that are needed. The extreme hardness of this Norton *engineered and prescribed* refractory gives the same excellent results where severe flame erosion is encountered.

Above this brick, the diagram also shows how the water tube front and rear arches are protected against hot, swirling gases by CRYSTOLON armor blocks. Their high heat release supports combustion and preheats any infiltrated air from the ash pit entering the main boiler section.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

New booklet gives you the whole story

The above is just one of the applications described in the new Norton 24-page illustrated booklet on *Refractories For Heat and Power*. To learn how these highly efficient, quality-controlled refractories supply a performance-improving Rx for every boiler application, write for your copy today. NORTON COMPANY, 449 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto 5, Ontario.

NORTON REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make other products better

United Towing Co. reports LATTICE BRAID* *outlasts* previous pump packings 26 to 1

*Registered Trademark. *Only* Garlock makes LATTICE BRAID rod and shaft packings.

United Towing Company of Wilmington, Cal. tried a number of packings on their rotary gear pumps handling *cold molasses* and operating at 120 p.s.i. In starting the pumps, the cold molasses would ruin these packings. In fact, no packing would last more than 8 to 10 hours. That is, until United Towing tried rugged LATTICE BRAID asbestos packing with wire insertion and wire corners. In actual running time, LATTICE BRAID has lasted for 260 hours—26 times longer than any previous packing.

Put Garlock LATTICE BRAID Packing to work for your company. All the braided strands of this unique packing are lattice linked together into one structural unit. The strands hold together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

LATTICE BRAID is made from flax, cotton, asbestos, wire-inserted asbestos, Teflon, and asbestos with Teflon impregnation—for various types of services.

Get all the facts about LATTICE BRAID *Packings. Contact your Garlock representative or write for new folder AD-131.*

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK LATTICE BRAID PACKING

More EQUIPMENT NEWS

Begins on page 166

probe to allow direct connection to voltage source with minimum of shunt capacity and series inductance.

Gertsch Products Inc, 11846 Mississippi Ave, Los Angeles 25, Calif.

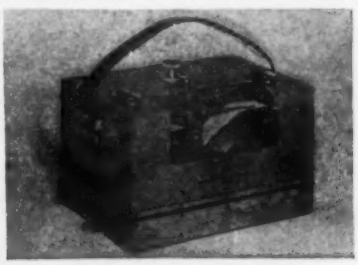
Unit type annunciator

1013 • Heavy duty annunciator called *Electro-Larm*, for single or multiple installation, has four distinct key positions indicating normal, alarm, pending and clear. Coiled spring provides motive power for automatic movements. Momentary alarms may be reset at once. Indication of abnormal conditions may be held after releasing audible signal but key remains illuminated and continues to indicate trouble. Units operate from either normally open or normally closed sensing device. A 5/8-in. hole through panel is only requirement for mounting. *Electro-Larm* can also be mounted adjacent to or in many instances on equipment being monitored.

Standard units are available for 115 and 230 v, ac, 60 cps, and 125 and 250 v dc.

Electro-Devices, Inc, 4025 Easton Ave, St Louis 13, Mo.

For more data on these items, use post cards p 175. Identify your request with item number.



Vibration recorder

1060 • Self-contained recording instrument for measuring accelerations and vibration displacements. Recording is made by sapphire stylus on waxed paper tape; no ink is needed. Instrument weighs 26 lbs. Unit may be used for general vibration studies.

Epic Inc, 154 Nassau St, New York 38, N. Y.

Corrosion-resistant bellows

1018 • Chemically inert, corrosion- and heat-resistant bellows made from *DuPont Teflon* are available with companion flanges conforming to American Standard bolt hole circles and numbers for pressures to 125 psi. They can be supplied to fit pipes from ½ through 12 in. Since the bellows retain formation at full free length, they are sub-

(*Continued on page* 196)

NEW!

TUBE-TURN Full-Encirclement Saddle improves "hot-tapping" of piping

SAFER, STRONGER "hot taps" are now made possible by the TUBE-TURN Full-Encirclement Saddle shown above. This new product is the first of a group of important developments of Tube Turns' unique pulsation pressure testing program.

Split longitudinally on a horizontal plane, perpendicular to the axis of the outlet, this new "hot tapping" reinforcement eliminates welds in the critical crotch area. Its installation requires a minimum amount of field welding. When used with high yield strength pipe, no welds are required between saddle and line pipe.

The TUBE-TURN Full-Encirclement Saddle is designed for high yield strength thin-wall pipe and for heavy wall cylinders used for headers, bottles and pulsation dampeners. It can be supplied for pipe sizes through 42", any outlet size, in composition and wall thickness to match service conditions.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Chicago • Denver • Los Angeles
San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

HOW INSTALLED

How to install the new TUBE-TURN Full-Encirclement Saddle for a "Hot Tap"

1. *Weld branch outlet pipe to run pipe according to normal procedure.*
2. *Position and block up bottom half of full-encirclement saddle.*

3. *Slip top half of full-encirclement saddle over branch outlet. Bring two halves together tightly by means of clamp such as shown.*

4. *Tack weld longitudinal lap plates to top half of saddle, remove clamp and complete welding of plates. (Plates are shop-welded to bottom half).*

5. *Fillet weld saddle outlet to branch pipe.* 6. *Join branch pipe to* TUBE-TURN *Welding Neck Flange. Normal tapping procedure follows.*

NOTE THAT when used with high yield strength, thin-wall pipe, as shown above, circumferential welds between saddle ends and run pipe are not required. This precludes possibility of failure due to underbead cracking or to local stress concentrations which exists at such attachment welds with conventional saddles or other types of "hot tap" fittings which must be fillet welded to high yield strength, thin-wall pipe. The TUBE-TURN Full-Encirclement Saddle fully meets all requirements for reinforcement of welded branch connections as developed by Section 8 of the Code for Pressure Piping.

This new, advanced design is another example of TUBE TURNS' pioneering... why it pays to do business with the leader.

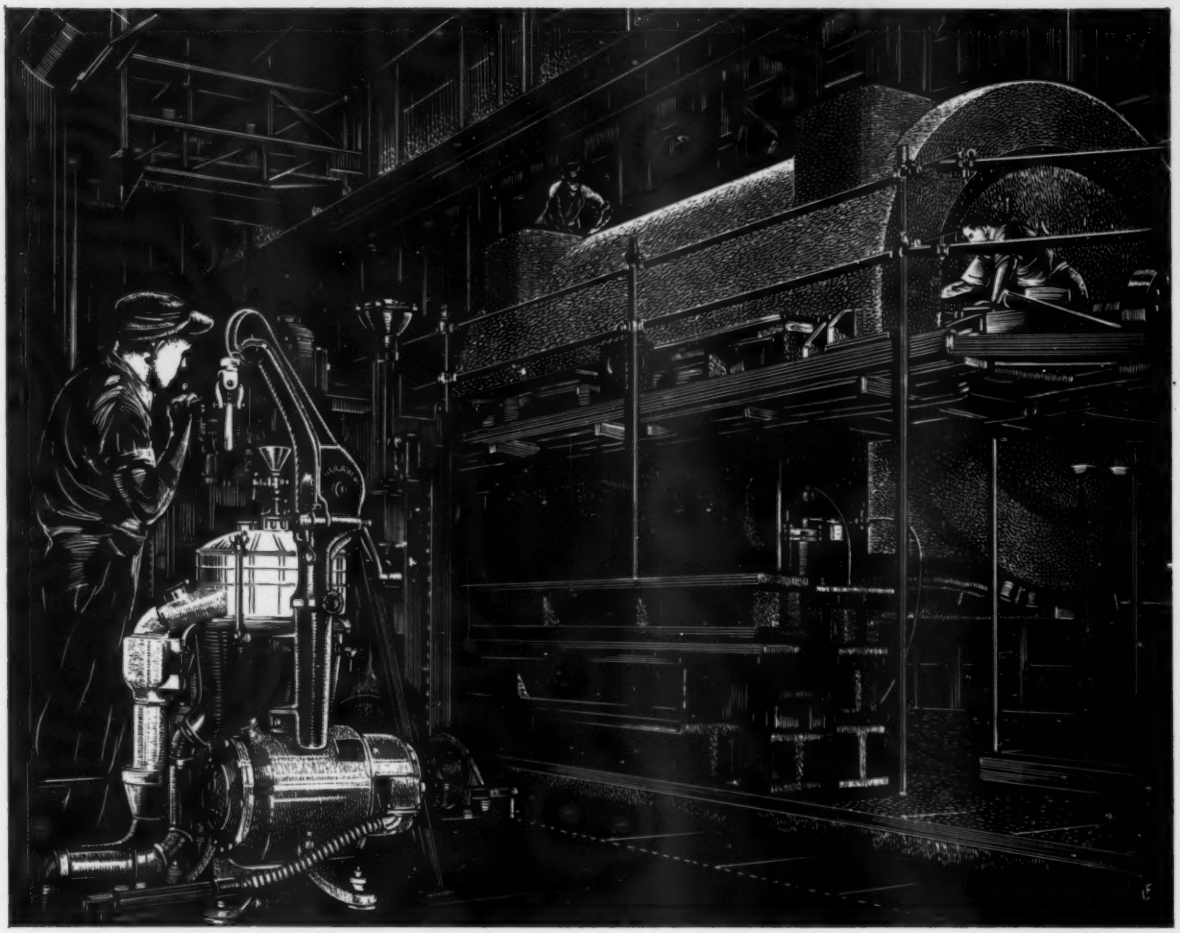
TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Chicago • Denver • Los Angeles
San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

TUBE-TURN

DE LAVAL TURBINE OIL PURIFIERS GET THE DIRT AND THE WATER



Purifying turbine lubricating oil is a *two-way* job—oil must be kept *clean* and *dry*.

De Laval Oil Purifiers score maximum on both counts. They not only remove solid contaminants from the oil, but also *dry it* at the same time. Neither dirt nor water can recontaminate oil during the process.

Furthermore, De Laval Oil Purifiers do *not* remove oil-soluble additives. Their action is entirely mechanical.

Leading turbine manufacturers purify the oil used in flushing and testing their own new turbines with De Laval Centrifugals. There's no stronger recommendation!

DE LAVAL

TURBINE OIL PURIFIERS

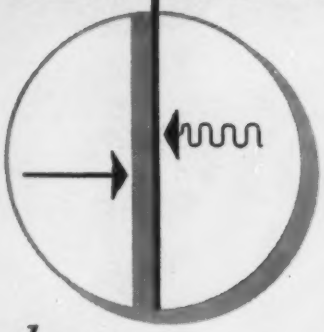
for More Dependable Power Production

THE DE LAVAL SEPARATOR COMPANY

Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5

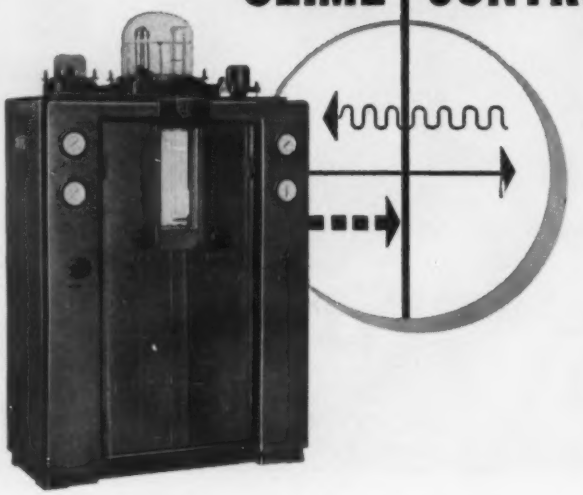
Where you need

HEAT | EXCHANGE



Be sure you have

SLIME | CONTROL



Whether you heat or cool water for make-up, process or any other use, you will need Wallace & Tiernan Chlorination to help combat slime problems introduced by water-borne bacteria or air-borne bacteria.

With slime control equipment designed for any need, built for lasting and dependable service, highly accurate and backed by over 40 years of successful application experience, Wallace & Tiernan Chlorination can help you increase the efficiency of your plant and cut operating costs. For further information write our Industrial Division.

WALLACE & TIERNAN

25 MAIN ST., BELLEVILLE 9, N. J.

CHLORINATORS • CHEMICAL FEEDERS • SCREENING EQUIPMENT • MAGNETIC SEPARATORS • PRECISION PRESSURE INSTRUMENTS • CATHODIC PROTECTION • FINE CHEMICALS

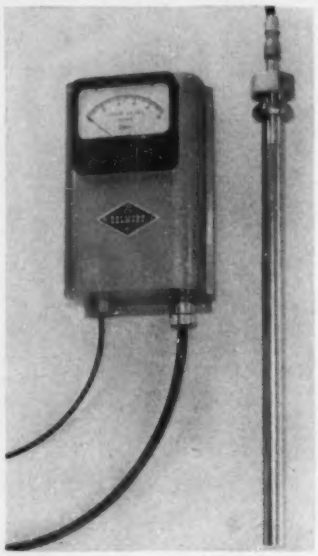
CD-39

More EQUIPMENT NEWS

Begins on page 166

jected to minimum residual and working strain. They expand and contract in either direction with equal freedom of motion. Operating temperature range is from –94 to 500 F. Typical applications include vibration dampers, expansion joints and connectors. Suitable designs are available for metering pumps, pressure accumulators, batching scales and hydraulic systems.

Crane Packing Co, Dept PRN, 1800 Cuyler Ave, Chicago 13, Ill.



Capacitive level-indicator

1033 • Instrument utilizes a capacitive-type sensing-element probe, with no floating or moving parts nor contact-making electrodes, to provide continuous indication of level for materials in storage or process. Indicator operates over a temperature range of 500 to –425 F, and from high vacuum to 100,000 psi. Various probe lengths, materials and designs cover different ranges in rise and fall of materials and character of substances encountered.

Thermo Instruments Company, 1310 County Rd, Belmont, Calif.

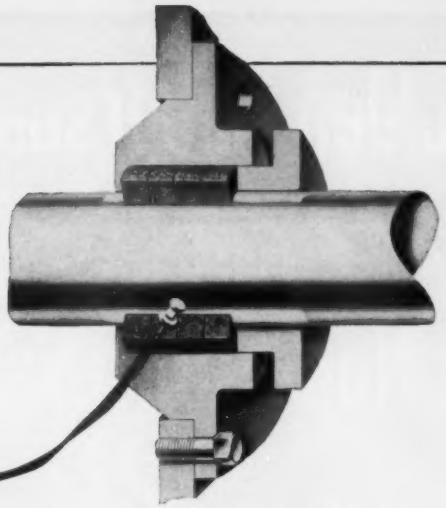
For more data on these items, use post cards p 175. Identify your request with item number.

Sensitive electronic relay

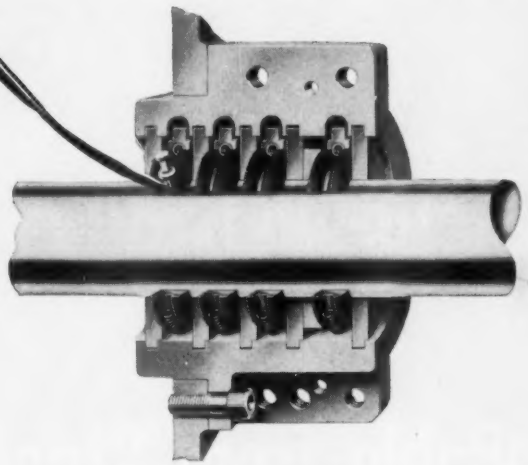
1037 • Extremely sensitive electronic relay, for use in remote control applications as well as temperature control, will operate on a closure through resistance of several megohms. Output circuits handle load of 1500 w or 2 hp and normally closed and normally open receptacles are on front panel of the instrument so temperature can

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



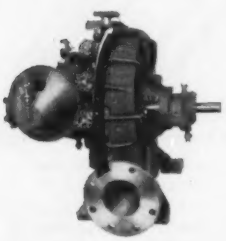
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
170 Park Avenue
Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

Golden-Anderson

Cushioned

Boiler Non-return Valves

and

Steam Check Valves

in sizes

2" through 30"

are now

Available from Stock

IN MOST SIZES

wire, write or call

GOLDEN ANDERSON *Valve Specialty Company*

1241 RIDGE AVENUE, PITTSBURGH 33, PA., FAirfax 2-8130

DESIGNERS AND MANUFACTURERS OF:

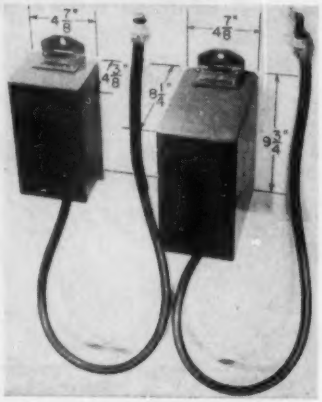
Non-Return Valves • Altitude Valves • Solenoid Valves • Engine Stop Valves • Swing Check Valves
Float Valves • Pressure Reducing Valves • Surge Relief Valves for air, gas, steam and water

More EQUIPMENT NEWS

Begins on page 166

be controlled to better than .005 C. The 4x5x6-in. unit has unshielded control terminal leads that can be 100 ft or longer.

Deltron Inc, 2905 Leithgow St, Philadelphia, Pennsylvania

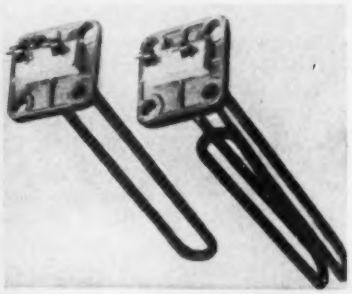


Weatherproof capacitors

1061 • Designed for indoor or outdoor applications on 460-v distribution systems, these capacitors are suitable for power factor improvement on isolated installations. Aluminum case protects against corrosion. Units are 3-phase, 460-v. Smaller unit is rated 2 and 3 kvar; larger at 4, 5 and 6 kvar. Full infoormation from manufacturer.

Westinghouse Electric Corp, Box 2278, Pittsburgh 30, Pa.

For more data on these items, use post cards p 175. Identify your request with item number.



Flange-type immersion heater

1062 • These heaters, designed to operate on either ac or dc circuits at 115 or 230 v, can be used in water baths, cleaning tanks, humidifiers and similar equipment. A silicone seal and porcelain insulator is incorporated at the heater's terminal ends as a protective measure against vapors and liquids, and to provide electrical insulation. The units are suitable for working pressures to 125 psi. Request data on *Calrod* immersion heaters for full information.

General Electric Co, Schenectady 5, N. Y.

Herringbone speed reducers

1063 • New line of herringbone speed reducers is produced in 60 standard ratios from 1.27 to 1 up to 355.8 to 1. All units are available in types suitable for either

6 STAR FEATURES

WHO SAID THERE'S NOTHING NEW IN CENTRIFUGAL PUMPS

B & G SERIES 1510 TYPE B CENTRIFUGAL PUMP

Years ahead! A VERTICAL split case pump with balanced loading of impeller and bearings...capable of handling loads far in excess of those produced by any pump and motor combination! Easily serviced without breaking pipe connections!

1. **Solid-type Volute with Support Foot.** Can be left in pipe line when servicing pump—rugged construction absorbs piping strains.

2. **Removable Bearing Frame.** Complete bearing frame, including seal and impeller, can be removed without disturbing piping or motor leads. The bearing frame is replaceable and interchangeable on all sizes.

3. **Leak-proof Mechanical Seal.** Features the exclusive, harder-than-glass B&G "Remite" insert. This Seal Construction has enabled nearly two million B&G Pumps to make an amazing record for failure-proof performance.

4. **Hydraulically Balanced Impeller.** Balancing chamber and pressure relief holes in the impeller reduce thrust to a minimum, lengthening pump life.

5. **Anti-Friction Roller Bearings.** Timken Bearings handle thrust and radial loads for smoother, quieter, more efficient operation.

6. **Oil Lubrication.** No messy, undependable grease cups—circulating oil lubrication assures positive protection to bearings. Oil level indicator permits visual check.

SEND TODAY FOR SIZE AND CAPACITY DATA

BELL & GOSSETT COMPANY

Dept. DP-36, Morton Grove, Illinois

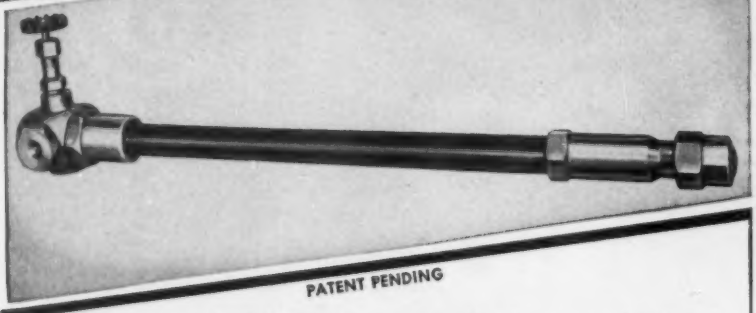
Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto, Canada

NATIONAL AIROIL

OIL BURNERS

of the steam and mechanical types now combined into

DUAL STAGE BURNERS



PATENT PENDING

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

42 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

- OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
- STEAM ATOMIZING OIL BURNERS
- SLUDGE BURNERS, Steam Atomizing
- MOTOR-DRIVEN ROTARY OIL BURNERS
- MECHANICAL PRESSURE ATOMIZING OIL BURNERS
- DUAL STAGE, Combining Steam and Mechanical Atomization
- LOW AIR PRESSURE OIL BURNERS
- AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
- GAS BURNERS
- COMBINATION GAS & OIL BURNERS
- FUEL OIL PUMPING and HEATING UNITS
- FURNACE RELIEF DOORS
- OBSERVATION PORTS
- SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

More EQUIPMENT NEWS

Begins on page 165

coupled or overhung load applications. Nine standard shaft extension assemblies and two standard bed-plate styles available.

Features include anti-friction bearings throughout; high test alloy iron housings; large inspection openings. Write on business letterhead for 160-page Engineering Catalog No. 100.

W A Jones Foundry & Machine Co, 4401 W Roosevelt Rd, Chicago 24, Ill.

Snap-on pipe insulation

1064 • Refrigerated and heated lines, to 350 F, can be insulated with this one-piece molded pipe insulation of glass fiber. It can also be used as a second layer on high temperature lines. It is practically unaffected by wetting or bumping. The material is light in weight and easy to install. K factor is 0.23 at 100 F mean temperature. Complete information and samples available from manufacturer.

Gustin-Bacon Mfg Co, 210 W 10th St, Kansas City, Missouri

For more data on these items, use post cards p 175. Identify your request with item number.

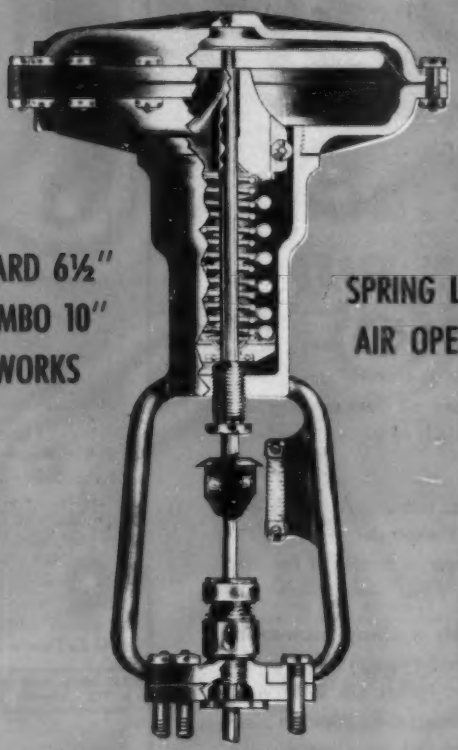
High pressure couplings

1065 • Reusable high pressure, hose couplings are available in standard range of sizes for wire braided, rubber covered hoses. Units are engineered for easy on-the-job installation requiring no special tools for hose assemblies. Both fixed and swivel male end couplings are available. Couplings will withstand pressures greater than rated burst

FOR BETTER CONTROL

USE BS&B CLIMAX

TYPE 86-TW DIAPHRAGM OPERATORS



STANDARD 6½" OR JUMBO 10" TOPWORKS

SPRING LOADED AIR OPERATED

This versatile Climax Type 86-TW Diaphragm Operator is a modified version of the controlling mechanism of the famous BS&B Climax Type 86 Control Valve. It has been adapted for use with a variety of other valves, instruments and controls such as butterfly valves, diaphragm valves (Saunders Patent), engine throttles and other controls where controlling pressure is available for translation to reciprocating motion.

Available in either the Standard 6½" or Jumbo 10" size, this versatile topworks is spring loaded and operates from compressed air or other medium. Yoke, spring case, diaphragm case and plate are of high tensile cast iron. Stems are of stainless steel with bronze connector of unique construction. Diaphragm is of cotton or nylon neoprene. Roller bearings on the spring guide reduce friction loss to a minimum.

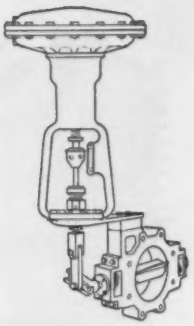
For more complete information on the Climax Type 86-TW Diaphragm Operator or on other Climax Controls, ask your BS&B Man or Sales Representative, or write to . . . .

CLIMAX BS&B CONTROLS OVER 60 YEARS

BLACK, SIVALLS & BRYSON, INC.

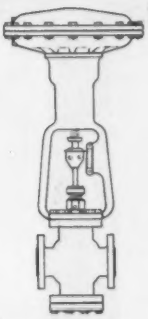
Climax Controls Division Dept. 4-Q10

7500 East 12th St. Kansas City 26, Missouri



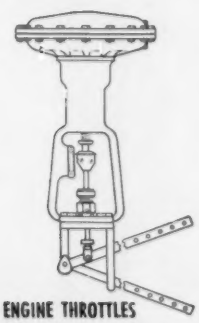
FOR BUTTERFLY VALVES

Climax Type 86-TW Diaphragm Operator is ideal for automatic control of butterfly valves. Mounts easily on any make of valve, and can be set for any specified operation of the valve.



FOR DIAPHRAGM VALVES

First developed for use on diaphragm valves, Climax Type 86-TW Diaphragm Operator has large diaphragm area and variable spring loading to insure minimum hysteresis.



FOR ENGINE THROTTLES and Other Controls

Wherever a sensitive yet positive reciprocal controlling motion is needed, such as on engine throttles, speed governors, cooling tower weirs, valve levers, etc., the versatility and adaptability of the Climax Type 86-TW Diaphragm Operator make it the ideal selection.

Versatile

INDUSTRIAL SOLVENT PUMP

(FIGURE 4703)

Features of this unit extend its scope of applications from pumping gasoline and oil from underground tanks to pumping many kinds of industrial solvents and other liquids.

For hazardous conditions, this pump is furnished with a vertical solid shaft explosion proof motor. Standard open type motor is furnished for non-hazardous conditions.

Since the Turbine assembly is always submerged, the liquid is actually pushed through the system in a steady continuous flow. Pumps are self-venting and do not vapor lock. Priming difficulties are eliminated and instant delivery of gasoline assured, regardless of outdoor temperature conditions.

Other features of this efficient pumping unit merit your investigation. Capacities range from 15 to 75 g.p.m. for pressures up to 100 lbs. (depending upon capacity).

Write for complete details.

THE DEMING CO.
547 Broadway • Salem, Ohio

Specify- **DEMING PUMPS**

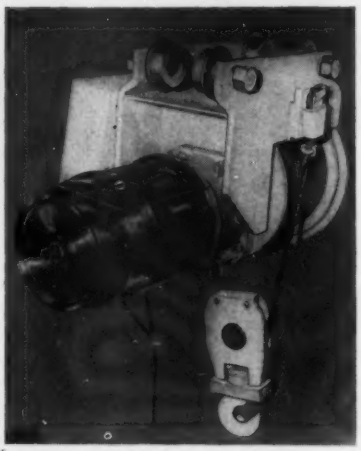
More EQUIPMENT NEWS

Begins on page 166

pressures of wire braid hose and other types of couplings, according to manufacturer.

Firm also announces a leakproof, 90 deg swivel-elbow for high pressure hydraulic equipment. Full range of sizes for all standard applications are available. Elbows are designed to adjust to any angle in relationship to other connections. Full information on both products in catalog 504.

Condamatic Co, Inc, 332 W 21st St, New York, N. Y.

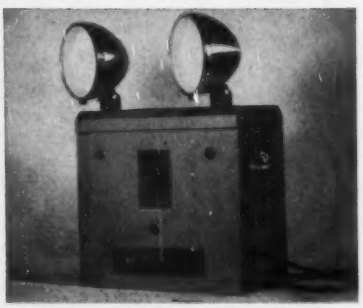


Heavy-duty hoists

1066 • A new line of hoists will have capacities from 4 tons upward. Standard models of 4, 5 and 6-ton capacities have wire rope lift, with swivel hook suspended on a two-part line. Units are all-steel welded construction, with the electrical components protected for outdoor, year round operation. Suspension is by lug, hook, plain or geared trolley.

R G LeTourneau, Inc, Longview, Texas

For more data on these items, use post cards p 175. Identify your request with item number.



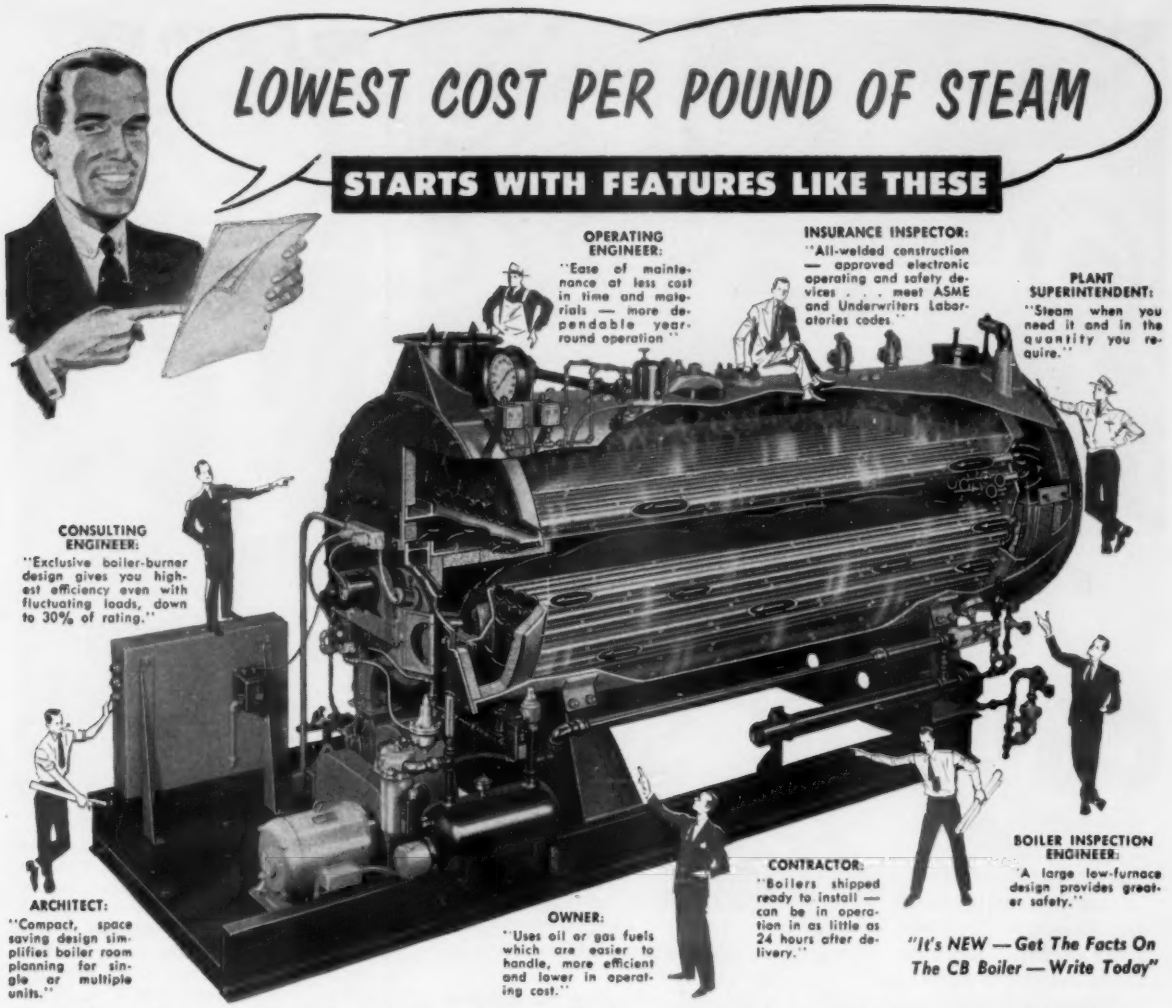
Emergency lighting unit

1067 • Nickel cadmium battery emergency lighting unit designed to provide an auxiliary 6-volt light source which will come on instantaneously and automatically when normal ac supplies fail. Nickel cadmium battery has a long life and requires minimum of maintenance.

Mounted on top of unit are two 6-v lamp heads and reflectors. Front panel mounting includes a high-rate charge timer that can be set from 0 to 12 hrs, amber neon readiness light, a red neon high rate light, a 6-v

LOWEST COST PER POUND OF STEAM

STARTS WITH FEATURES LIKE THESE


OPERATING ENGINEER:
"Ease of maintenance at less cost in time and materials — more dependable year-round operation."
INSURANCE INSPECTOR:
"All-welded construction — approved electronic operating and safety devices . . . meet ASME and Underwriters Laboratories codes."
PLANT SUPERINTENDENT:
"Steam when you need it and in the quantity you require."
CONSULTING ENGINEER:
"Exclusive boiler-burner design gives you highest efficiency even with fluctuating loads, down to 30% of rating."
ARCHITECT:
"Compact, space saving design simplifies boiler room planning for single or multiple units."
OWNER:
"Uses oil or gas fuels which are easier to handle, more efficient and lower in operating cost."
CONTRACTOR:
"Boilers shipped ready to install — can be in operation in as little as 24 hours after delivery."
BOILER INSPECTION ENGINEER:
"A large low-furnace design provides greater safety."

"It's NEW — Get The Facts On The CB Boiler — Write Today"

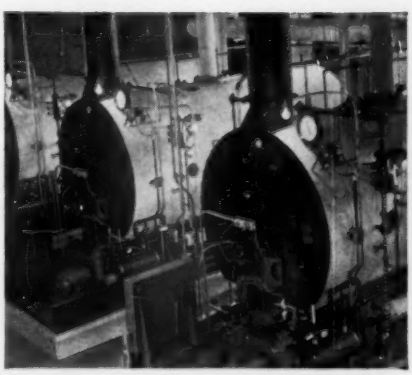
that's why you profit most from Cleaver-Brooks self-contained boilers

• Top to bottom, inside and out, you get more money-saving features when you specify or buy Cleaver-Brooks self-contained boilers. You make an *investment in quality* that pays off in lowest net cost per pound of steam for processing or heating.

YOU BENEFIT from more than 20 years of experience, working closely with men who have made it their business to be *right* about boilers. You profit from complete coordination throughout planning, installing, supervising and final operation.

YOU BENEFIT from self-contained design and original four-pass construction. These Cleaver-Brooks engineered "firsts," plus forced draft, 5 sq. ft. of heating surface per boiler hp, and exclusive burners, all contribute to highest heat transfer. Guaranteed 80% thermal efficiency when firing with oil is the direct result!

Whether you're planning a new steam plant or modernizing, make certain you get the complete Cleaver-Brooks story before you buy. See your Cleaver-Brooks representative, or write for catalog AD-100. Cleaver-Brooks Company, Dept. L-300, 326 East Keefe Avenue, Milwaukee 12, Wisconsin, U.S.A. *Cable Address CLEBRO — Milwaukee — All Codes.*



One typical owner can count on yearly savings ($15,000 fuel and $10,000 labor) from this battery of three 150 hp Cleaver-Brooks self-contained boilers.

•

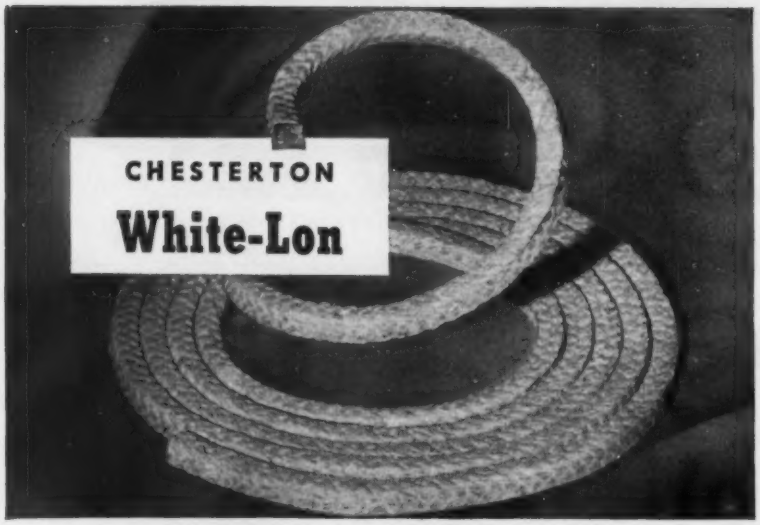
NOW — FIRST SIZES OF THE CB BOILER ARE MADE IN CANADA, TOO.

•

Cleaver Brooks

ORIGINATORS OF THE SELF-CONTAINED BOILER

BOILERS . . . STEAM OR HOT WATER . . . FOR HEATING OR PROCESSING, IN SIZES FROM 15 TO 500 hp, 15 to 250 PSI.



NEW PACKING DEVELOPED BY CHESTERTON FOR

caustic soda

Whether it be for Sodium, Potassium, Calcium, Ammonium, Barium or Magnesium Hydroxides, or in fact any strong alkali, White-Lon, Chesterton Style No. 322 will make a tight, trouble-free, lasting and alkali-proof *packing seal*.

Chesterton White-Lon is especially designed for an effective packing seal against all liquids of high pH value. White-Lon is the first packing designed solely for this extremely difficult condition. It is manufactured from chemically pure Chrysolite Canadian Asbestos. In our exclusive process, *each strand* of this fine yarn is immunized against caustic action by treatment with DuPont *Teflon* Suspensoid in the same exclusive manner as is our famous Blu-Lon acid packing.

White-Lon is ideal for stainless steel and chrome plated shafts. It is white in color, contains no graphite but has received a light breaking-in lubrication.

There are Chesterton Distributors in every city. Write for the name of your nearest supplier.

A pH SCALE FOR CHEMICAL PACKINGS

1 TO 4	5 TO 10	11 TO 14
pH VALUES	pH VALUES	pH VALUES
STRONG ACIDS	WEAK ACIDS OR ALKALIES	STRONG ALKALIES
#320	#315	#322
Blu-Lon	Carsons	White-Lon

PACKING Chesterton SERVICE

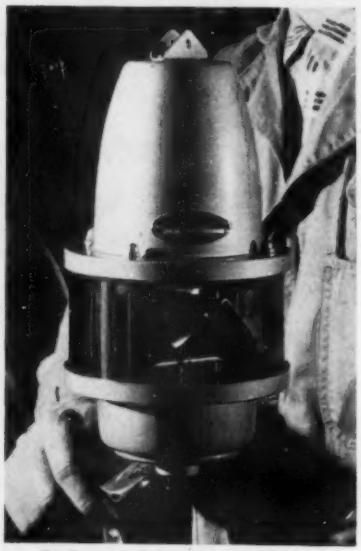
A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

More EQUIPMENT NEWS

Begins on page 166

light switch and a push button test switch. Removable sub-assembly carries the transformer, rectifier, cutover relay, timer, trickle-charge resistor and all other components. Full details on request.

Nickel Cadmium Battery Corp, Easthampton, Mass.

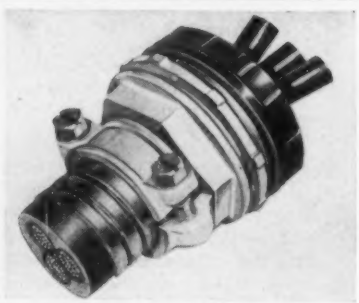


Industrial warning light

1068 • Electric signal light, *Beacon Ray 27-S*, indicates hazardous work areas, or can be used as a visual communication light in noisy shops. Unit is modeled after the company's revolving red flashing light for fire, police and other emergency vehicles. It uses the principle of a colored light beam revolving horizontally in a 360 degree arc, producing 100 flashes per minute. It operates on 110 v.

Federal Sign and Signal Corp, 8700 S State St, Chicago 19, Ill.

For more data on these items, use post cards p 175. Identify your request with item number.



Armored cable clamp

1069 • Speed and ease of installation is provided by *type PK* cable clamp, according to manufacturer. Features include slotted hex bolts that may be tightened by either wrench or screw driver and flanged body that eliminates need of an extra lock nut for securing clamp in the knock-out hole. Clamp has ample thread length for use with standard conduit fittings and

"You see Powell Valves everywhere! And with . . .

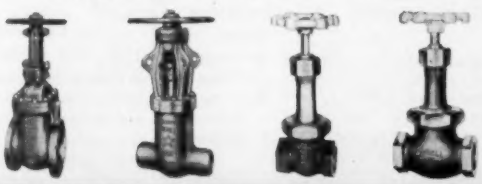
. . . good reason! They're famous for dependability. Economical, too.
What's more, Powell has a complete line."

Just name the valve needed...

. . . POWELL CAN SUPPLY IT! Small wonder—since Powell probably makes more kinds of valves and has solved more valve problems than any other organization in the world.

Available through distributors in principal cities. In bronze, iron, steel and corrosion resistant alloys. 1/8" to 30" and 125 pounds to 2500 pounds W.S.P. On problems, write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

CONTROLS FOR THE LIFE LINES OF INDUSTRY



Powell Valves

108th year

FOR REPLACEMENTS ORDER

ERNST

MASTER HIGH PRESSURE

GAGE GLASSES

FIG. 14
MASTER STANDARD RED LINE

and also

FIG. 12 MASTER STANDARD CLEAR
Up to 500 lbs.

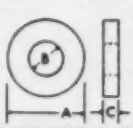
Noted for high pressure and temperature.

RUBBER GASKETS
HIGH PRESSURE COMPOSITION

FIG. 22—Standard

FIG. 21—Lip Mold

Manufactured in all sizes to fit your water gages and valves.



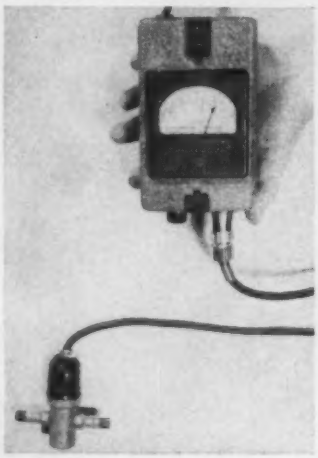
Specify:
B—Inside Diameter
A—Outside Diameter
C—Thickness

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.
Gentlemen:
Please send me BULLETIN 1-6-54 today
NAME .....
COMPANY .....
ADDRESS .....

More EQUIPMENT NEWS

Begins on page 166

terminators from 1 to 5 in. Available for interlocked armored cable from .99 to 4.38-in. O.D. Full details from manufacturer.
O Z Electrical Manufacturing Co, Inc, 262 Bond St, Brooklyn 17, N. Y.



Small electronic flowmeter

1070 • Small, 27 oz unit for instantaneous direct readings of gas flow in 50 to 10,000 cc per min range. Directly heated thermocouple gauge tube can be placed in line for low flow rates with practically no pressure drop in line. Unit can be used with long extension cables for remote indications.
Hastings Instrument Co, Inc, HICO Instruments Div, Warwick, Va.

For more data on these items, use post cards p 175. Identify your request with item number.

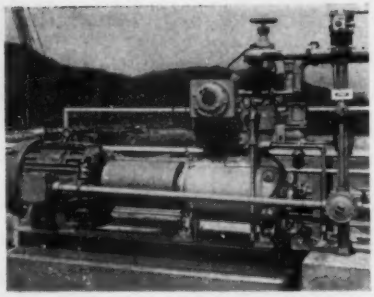
Anti-seize thread compound

1042 • Thread compound is said to eliminate seizing and galling at operating temperatures to 1200 F. Called *Thred-Gard* it is non-hardening and acts as a lubricant to allow easy dis-assembly of threaded connections. Compound also prevents damage to stud, bolt, pipe joint and plug threads. By reducing wrench torque, *Thred-Gard* allows fitting to be drawn tighter without undue stress or strain. It acts as protective coating to keep threaded surfaces smooth and insure pressure-tight, metal-to-metal contact, according to manufacturer.
Crane Packing Co, Dept PRN, 1800 Cuyler Ave, Chicago 13, Ill.

Low-toxicity solvent

1071 • *Vythene*, low-toxicity safety solvent is only 1/20 as toxic as carbon tetrachloride. Solvent is non-flammable, fast evaporating and suitable for a variety of industrial uses. It may be used for cleaning electric motors and equipment, plant maintenance, wax dispersion or removal, cleaning machinery.

Showing excellent stability for all metals including aluminum, brass and copper, even at the boiling point of the solvent, *Vythene* is non-corrosive to brass and copper and practically inert to ordinary electrical insulating varnish and materials.
Tect, Inc, Cortlandt and Erie Sts, Dumont, N. J.



Pumping Propane With a

FRICK

"ECLIPSE" Compressor

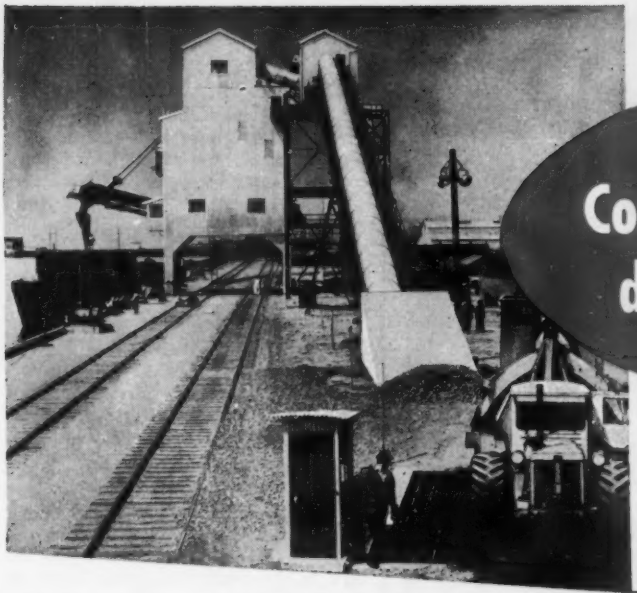
The Tennessee Eastman Company, at Kingsport, uses this 3-cylinder Frick compressor in transferring propane from tank cars to the storage tanks shown in the background. Explosion - proof controls were furnished for this exacting service.

Many Frick compressors are used for transferring ammonia, also for handling carbon dioxide, ethylene, and other gases.

Whether you need equipment for processing, air conditioning, ice making, quick freezing, or other cooling work, there's a Frick refrigerating system to meet your requirements. Let us submit estimates.

FRICK CO.
WAYNESBORO, PENNA. U.S.A.

Below: Frick compressor transferring ammonia at the Frisco (Texas) Fertilizer Co.



New Coal Handling System designed for today

...and tomorrow

by HEYL & PATTERSON

WHEN formulating plans for their new Northeast Coal Storage Yard, engineers of the Philadelphia Electric Company planned for the future when the new yard will probably require unloading equipment to supplement the facilities at nearby locations.

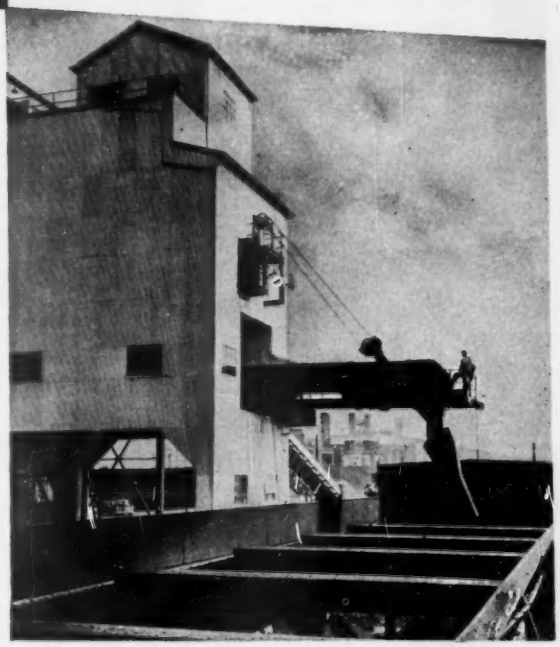
Heyl & Patterson designed, fabricated and erected this modern coal handling system that handles today's needs with precision and efficiency . . . and is also designed to fit in with plans for future requirements.

This coal handling system illustrates the constant aim of Heyl & Patterson . . . to work hand-in-hand with the customer to provide the very best Heavy Bulk Materials Handling Equipment to answer the customer's particular needs.

When *your* problem centers around the handling and transportation of coal, ore, limestone or any Heavy Bulk Material . . . take advantage of the complete engineering, fabricating and erecting facilities of Heyl & Patterson. Think first of Heyl & Patterson . . . with over 65 years experience in the specialized field of Heavy Bulk Materials Handling.

TOP PHOTO . . . Coal being reclaimed at Philadelphia Electric Company's Northeast Coal Storage Yard is dumped into a sunken hopper and carried by means of a belt conveyor to the top of the loading tower where it is deposited into a 250-ton-capacity storage bin. The coal is then fed from the storage bin either to the barge loader or into railroad cars or rubber-tired mobile equipment.

A series of lights in the operator's station indicates the amount of coal in the hopper at all times. The entire system is automatically "tripped-out" by the "full" indicator.



SHOWN HERE . . . Barge loading at 800 tons per hour is accomplished by a 37′ loading boom which can be raised or lowered to meet all barge-loading conditions. Barges are trimmed by the swinging chute at the discharge end of the loading boom.

All conveyors and gates of the conveying system are interlocked to prevent "pile-ups" in case of failure in any part of the system.

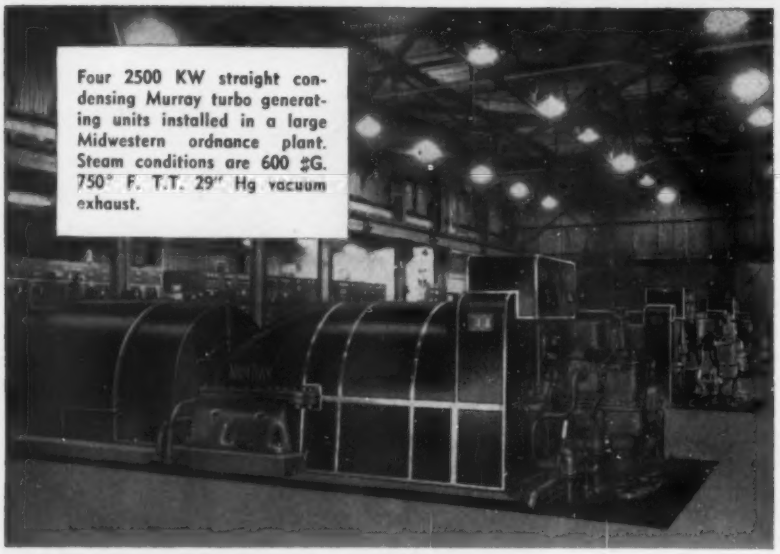
- Coal Handling Equipment
- Boat Loaders & Unloaders
- Coal Storage Bridges
- Coal Preparation Plants
- Cyclone Thickeners
- Reineveld Centrifugal Dryers
- Thorsten Coal Samplers
- Bradford Breakers
- Coal Crushers
- Rotary Mine Car Dumpers

Heyl & Patterson, Inc.

"SINCE 1887"

55 FORT PITT BLVD. PITTSBURGH 22, PA.

Murray Turbines



Four 2500 KW straight condensing Murray turbo generating units installed in a large Midwestern ordnance plant. Steam conditions are 600 #G. 750° F. T.T. 29" Hg vacuum exhaust.

● Murray Turbo Generator units can be furnished to meet your special requirements in sizes up to 3000 KW. Condensing and non-condensing types with or without extraction and/or mixed pressure features can be furnished. Whether you require a small inexpensive standby unit or a highly efficient, and reliable source of power, Murray has a design to fit your needs.

Consult your local Murray representative who will gladly help you select the unit most economically suited to your conditions.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

MARMADUKE

Continued from page 154

back to the bar. And that's when we got a true picture of Marmy's character. Now we know he isn't tough because he has size and muscles to back him up—he's tough because he has that inner self-assurance that comes only from knowing your business so well that you don't back away from anyone. It's a case of knowledge being power. And Bull sensed that, whether he had enough brains to think of it or not.

"OK," yelled Bull finally in defense. "It's a bet. I'll take you over to my plant right now, put Number 2 boiler on hand control—then come back here to collect that bet—and I'll make you eat your words."

In almost nothing flat the Bent Propeller was empty, save for the bartenders and a few bar flies. Bull, Marmy and his old shipmate Bedlam led the way to the ferry boat, with 26 of us disciples of Marmy following in their wake Before long we were inside one of the neatest, most modern boiler rooms anywhere. Bull hot-footed over to the control panel of Number 2 boiler without wasting time. You could tell he expected this to be a pushover. He removed the chart and replaced it with a new one. Then he looked up at the big boiler-room clock and got into action. A few adjustments and he had her on manual.

Marmy sat down behind the log desk and heaved his Number 16 canal boats up on it. Then he calmly puffed away on his rope yarn, and watched Bull. Soon it was clear to all of us that Bull had his hands full, what with watching the draft, pressure and other instruments that gave vital facts about the boiler's operation.

As loads changed, he consulted six instruments quickly, then he'd make adjustments to coordinate combustion with steam demand. Marmy just sat there, watching Bull's maneuvers with a sly expression on his weather-beaten face.

Weary and shaky after his hour was up, Bull removed his chart and replaced it with a new one. He wasn't cocky now and seemed a bit concerned. Then Marmy stepped to the control panel. The old consulting engineer was as confident as a shark chasing a barracuda.

Marmy quickly made several adjustments on the automatic-manual subpanels without even looking at the instruments and controls that Bull monkeyed with. During his hour, he paced back and forth, making corrections on the manual subpanels and never once glanced at the steam-pressure chart or the draft instruments. Bull just sat there in back of the desk, with a puzzled look on his face. You could see he was burn-

MAINTENANCE MEN PREFER
O-B VALVES BECAUSE OF . . .

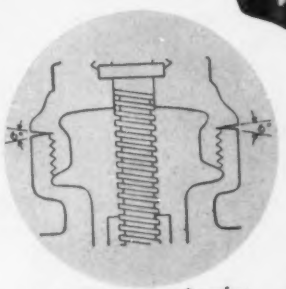
Self-Sealing, Lubricated centerpiece joints

● Plenty of valuable minutes have been saved for maintenance men by the O-B practice of lubricating joints on all valves. Months after the O-B valve is installed, it can be quickly "broken" at the centerpiece joint to remove the trimmings. Or the packing nut can be easily loosened if the valve needs repacking. This is possible because each valve joint is lubricated when assembled at the O-B factory.

Re-assembly is made easier by the self-sealing feature of the joints. A three-degree chamfer has been machined on each face...providing just enough clearance to set up a narrow metal-to-metal contact line all around the joint. Contact pressure is much higher than a wider surface would permit. No gasket or compound is needed to make an effective seal.

These are just two of many features that have made O-B bronze valves popular in the industrial maintenance field. They're available with threaded or tubing ends, with rising or non-rising stems, and for up to 200 pounds working steam pressure, depending on the type of valve. Your O-B distributor carries the complete line.

Ohio Brass Company
Mansfield, Ohio



A three-degree chamfer has been machined on each joint face, providing clearance for a narrow, tight line of metal-to-metal contact.

Ohio Brass Valves

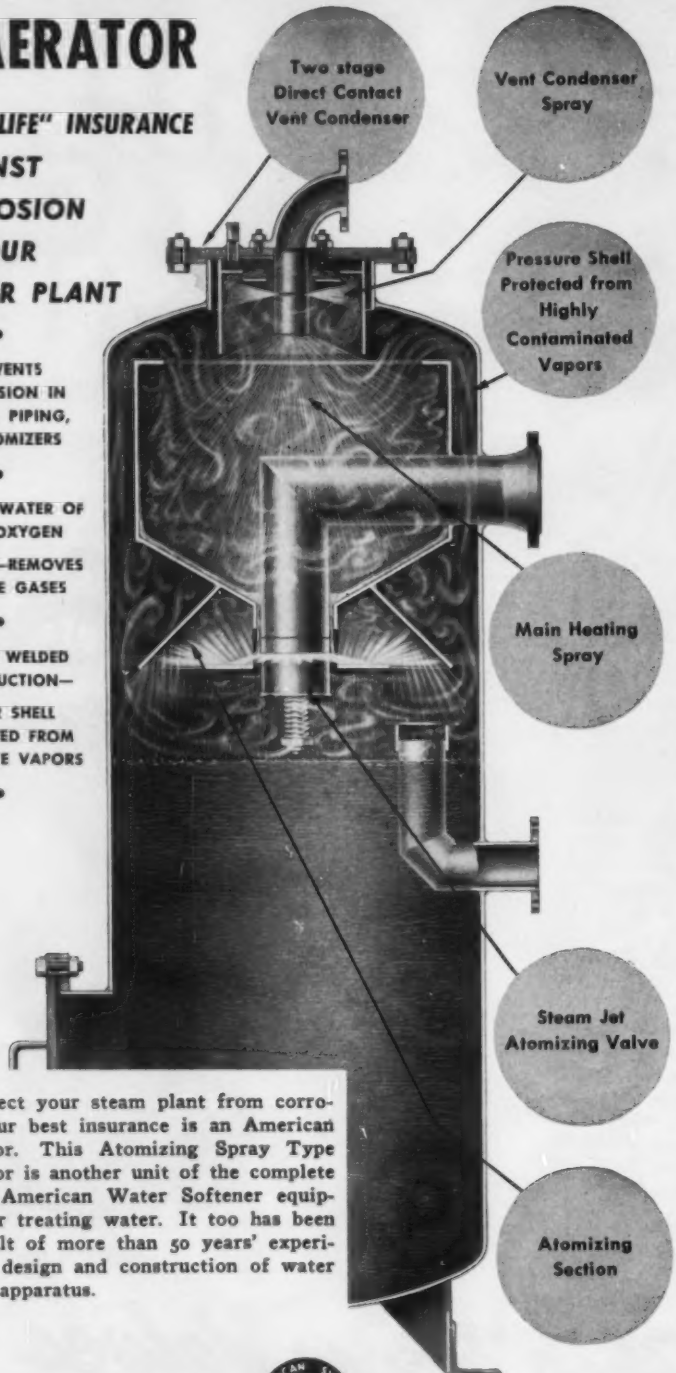
BRONZE GLOBES, ANGLES, GATES AND CHECKS FOR
INDUSTRIAL AND DOMESTIC SERVICES

4447-V

AMERICAN ATOMIZING SPRAY DEAERATOR

"LONG-LIFE" INSURANCE AGAINST CORROSION IN YOUR POWER PLANT

- PREVENTS CORROSION IN BOILERS, PIPING, ECONOMIZERS
- DELIVERS WATER OF ZERO OXYGEN CONTENT—REMOVES SOLUBLE GASES
- STURDY WELDED CONSTRUCTION—OUTER SHELL PROTECTED FROM CORROSIVE VAPORS


Two stage Direct Contact Vent Condenser
Vent Condenser Spray
Pressure Shell Protected from Highly Contaminated Vapors
Main Heating Spray
Steam Jet Atomizing Valve
Atomizing Section

To protect your steam plant from corrosion, your best insurance is an American Deaerator. This Atomizing Spray Type Deaerator is another unit of the complete line of American Water Softener equipment for treating water. It too has been the result of more than 50 years' experience in design and construction of water refining apparatus.

SERVICE SINCE 1902 — TO THE INDUSTRY

AMERICAN *Water Softener* COMPANY
INCORPORATED

FOURTH AND LEHIGH AVENUE • PHILADELPHIA 33, PENNSYLVANIA

DEAERATORS • HOT PROCESS SOFTENERS • REACTORS • FILTERS • ZEOLITE SOFTENERS • CHLORIDE DEALKALIZERS • AERATORS & DEGASIFIERS
HYDROGEN SODIUM ZEOLITE SOFTENERS • DEMINERALIZERS • CHEMICAL FEEDERS • CONTINUOUS BLOWDOWN • SWIMMING POOL EQUIPMENT

MARMADUKE

Continued from page 208

ing up. Fact is, we all wondered why the old fox didn't look at his chart or draft instruments.

When Marmy's time was up, he removed his steam-pressure chart and threw it down on the desk for Bull to compare with his. We all stretched our necks trying to see them. It was clear that Marmy's chart had almost a perfect pressure line, while Bull's had several bad bumps and showed steam pressure varied a little above and below the required value.

Bull just stared at the charts without saying anything. But he was gradually getting pink around the gills. Then he jumped up suddenly from the desk, peeled six 10-dollar bills from his roll and threw them on the desk. Quickly he threw his coat over his shoulders and walked out of the boiler room, muttering to himself.

Going back on the ferry boat, we crowded around Marmy and asked him how he did it.

"Simple," roared our hero, his eyes following a round-the-world freighter as she glided past us down the river. "Many of these automatic boys don't know everything automatic controls can do. They don't know that when most automatic controls are on manual operation, the manual gage on subpanels shows the position of the control while the automatic gage, also on subpanel, shows what the position should be.

"In other words," he continued, looking at a chugging tug boat hurrying across our bow, "the automatic control is still sending out its automatic signal, but it's just not connected. All I did was operate the manual knob until the manual gage read the same as the automatic gage. That's about the same as having the controls on automatic operation. And that's why I beat Bull with his own controls."—*SME*.

PLANT LUBRICANTS

Continued from page 111

and its prospective protective film of lubricant, interfacial forces prevail that are controlled by the adhesion characteristics of the film. If it promotes good wetting ability, it may be presumed that the adhesion property is good. This depends to some extent upon the surface finish of the solid, and the method and degree of refinement of the lubricant. It has been said that too high a polish or surface finish is not conducive to good wetting ability or adhesion. It has also been suggested

(*Continued on page* 214)

PLASTICORK · · · *a granulated cork-and-rubber insulation that can be molded to any cold line fittings*

Now you can insulate irregular fittings without having to cut standard molded covers on the job or wait while special ones are factory made. With Armstrong's Plasticork®, the workman just shapes the covers as he goes, speedily and efficiently.

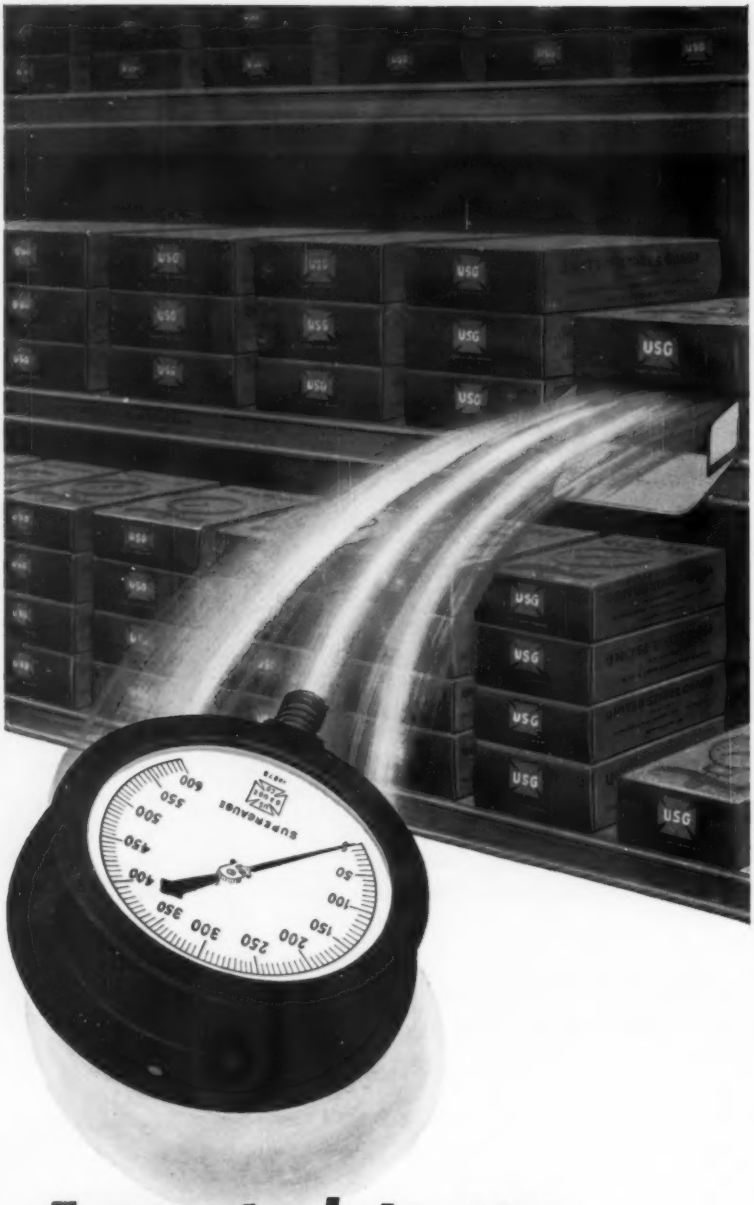
Plasticork is a granulated cork-and-rubber material made in sheet form. In covering a fitting, small chunks are pulled from a sheet and packed into all voids. Full insulation thickness is then built up with pieces or with full sheets, depending on the type of fitting. When finished, the fitting compares favorably in appearance and efficiency with a regular molded cover.

Plasticork is easy to warehouse. It can be stored indefinitely without loss of plasticity. It can also be removed from a fitting and used again without loss of its original insulating efficiency or workability.

Armstrong's continuing research in industrial insulations is helping to solve many high- and low-temperature insulation problems. For complete information on Plasticork, Armstrong's other industrial insulations, and Armstrong's Complete Contract Service, call your nearest Armstrong office or write Armstrong Cork Company, 204 Stratton St., Lancaster, Pennsylvania.

Armstrong's Insulcolor, a new plastic finish for insulated surfaces, is being applied to this Plasticork insulated fitting. Insulcolor can be used indoors or out, comes in a choice of seven colors and white.

ARMSTRONG'S INDUSTRIAL INSULATIONS



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In addition to the well stocked shelves of your USG Distributor, USG stocks over 200,000 gauges in a variety of types, sizes and ranges to meet every industry need.

Your USG Distributor has on his shelves, or can get for you fast, any quantity of gauges you want for any application. See your USG Distributor for all your gauge requirements.

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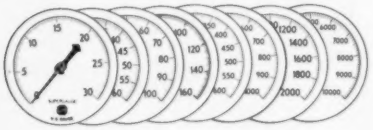
MANY USG STOCK GAUGES ARE "SPECIALS" WITH OTHER MAKERS

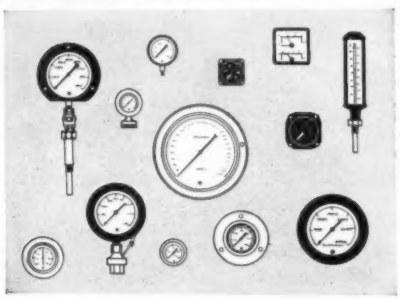
For over 50 years USG has been designing and producing gauges for more original equipment manufacturers than any other instrument company in the world.

Many of USG's "special" designs have become standard stock items in the industry. Many others that are "standard stock" at USG require expensive special production with other instrument manufacturers.



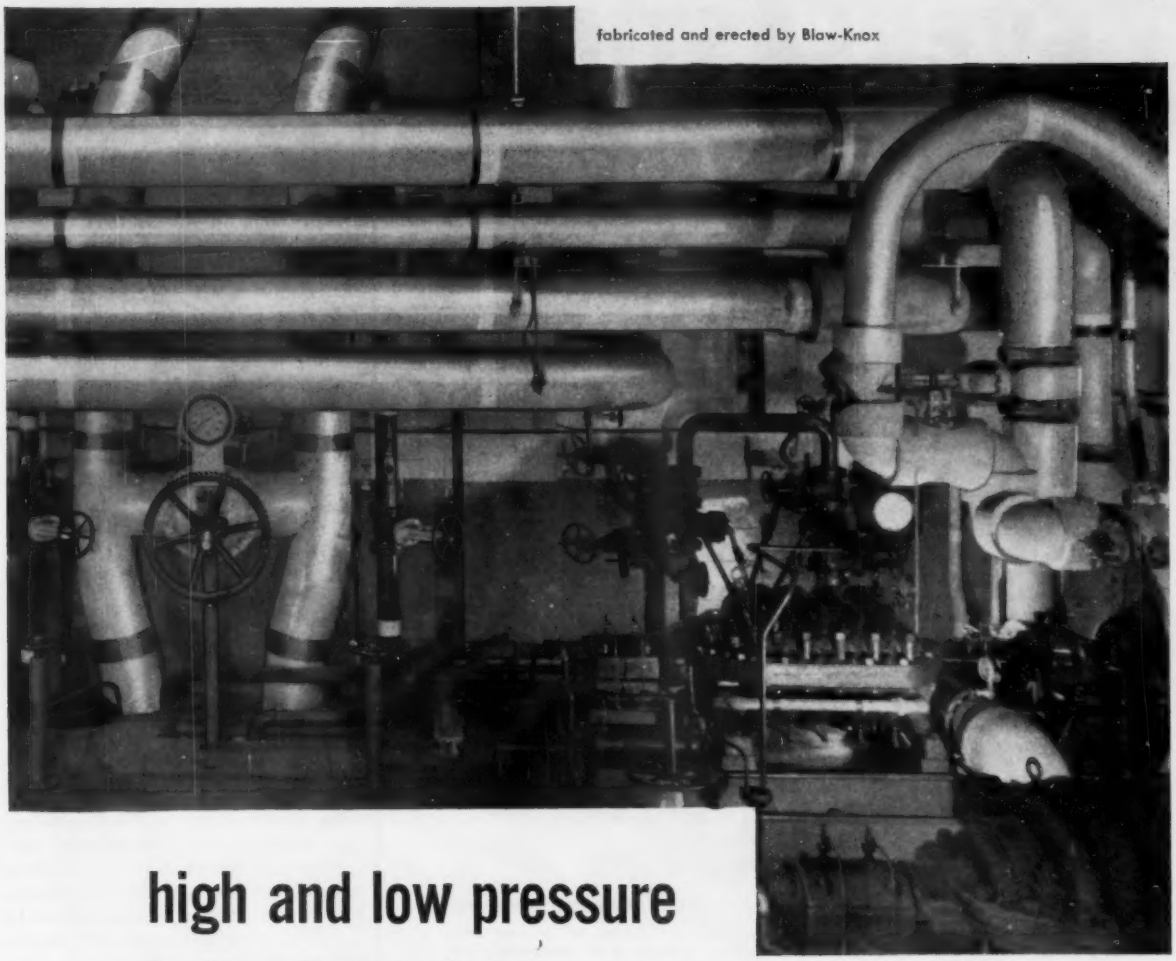
To meet the special gauge requirements of industry economically, USG maintains—in addition to its huge stocks of standard gauges—the world's largest inventory of gauge components to meet any pressure sensing and actuating need.

To assure higher quality gauges with enduring accuracy, USG maintains the most rigid quality control system in the industry. This rigid inspection system is supported by a Standards Laboratory with masters measuring from low vacuums to super pressures.



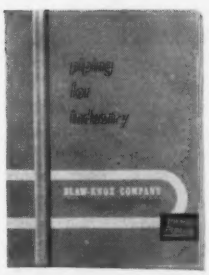
USG's wide experience in all pressure sensing and actuating applications, plus its economically integrated facilities for large volume, quality controlled production, permit a better gauge—with enduring accuracy—*in every competitive price class.*

UNITED STATES GAUGE



fabricated and erected by Blaw-Knox

high and low pressure boiler feed piping . . . in large steel mill



To get more information on piping for industry write for your copy of Bulletin No. 2443.

When you need a piping system similar to this one . . . or a system for any pressure and any temperature requirements . . . you can readily obtain the benefit of our long experience in this field. We'll take the job from original engineering to final erection. Always in close cooperation, of course, with your consultants or your own organization.

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Complete prefabricated power piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

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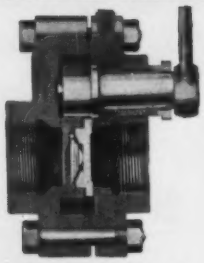
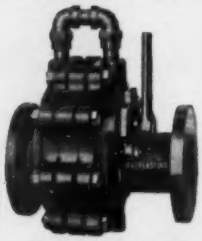
BOILER BLOW-OFF

Quick-opening, also hand-wheel operated. Angle and "Y" types and combination units meeting ASME Code requirements for pressures up to 600 psi.



GENERAL SERVICE

Wherever frequent use and quick operation is required for any liquid or gas at pressures up to 300 psi. These valves have outside stuffing box and gland.



STEAM JACKETED

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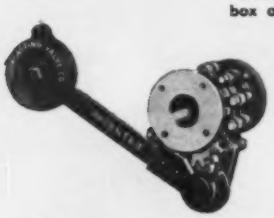
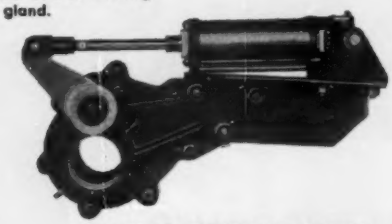


EMERGENCY PROTECTION

Closing type for inflammable liquid emergency shut-off, or opening type for deluge or drainage, assuring immediate and positive action with weighted pendulum stop.



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for accurate control of process work. Straight-through flow, drop-tight seal, air or hydraulic control for operation at any speed.

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Quick-Action . . . Opened or closed with less than a quarter turn of the operating lever.

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Drop-Tight Seal . . . constant contact of disc and seat at all times prevents dirt or scale from getting between.

Self Regrinding . . . the disc rotates on the seat with each operation, thus regrinding the sealing surfaces.

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for everlasting protection

PLANT LUBRICANTS

Continued from page 210

that an oil can be too highly refined, resulting in the same conclusion.

Use of additives to increase film strength under the proper conditions automatically promotes better contact or spreading of the lubricating film. However, high temperature must usually develop before the film-strengthening characteristics are brought into play. To use an EP lubricant at normal temperatures where high tooth load or bearing contact is not prevalent generally serves no purpose.

Adhesion is still an indefinite term associated with wetting ability and another intangible, *oiliness*. No really satisfactory method has been developed for its measurement. For this reason service-performance data are a more direct guide to the lubrication engineer when he is studying relative lubricating or endurance value.

NUCLEAR ENERGY

Continued from page 109

binding energy per nucleon. The change in binding energy largely went to develop kinetic energy of the fragments. This kinetic energy immediately converts to heat energy in the surrounding mass of uranium and fission products. Whenever a nuclear reaction moves in the direction of higher unit binding energies, it means that some small fraction of matter has changed to energy during the process.

The nuclei of the fission fragments are bound more tightly than they were in the original single large nucleus. This difference in terms of binding energies is about 0.9 mev per nucleon for the heavy nuclides. For uranium this releases about 200 mev per fission, most of it in the form of kinetic energy of the fragments and the ejected neutrons.

Conclusion. Any nuclear reaction in which the nucleons of the resulting fragments are more strongly bound than the particles in the original nucleus releases energy. We can do this two ways: (1) Combine light nuclides to form heavier intermediate ones, called *fusion*. (2) Break up heavy nuclides into smaller intermediate ones, called *fission*. A large percentage of the energy released by conversion of a small fraction of the mass during the reaction appears as kinetic energy of the end-product nuclei and quickly becomes heat energy.

Next part of the nuclear-energy study course will deal with Nuclear Reactions —watch for it in a forthcoming issue.

Startling Facts

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FREE!.....THIS FULL-COLOR PROFUSELY ILLUSTRATED BOOKLET OF FACTS THAT HAVE A BEARING ON THE LIFE OF YOUR MOTORS

Comparisons of methods for lubricating electric motors are interestingly depicted in this new booklet. It illustrates the three principal types of bearing systems used in motors—cartridge, one-side lubrication and Lubriflush—with explanations of the functions of each. For demonstrating the action of re-lubrication in the U. S. Lubriflush bearings, a transparent bearing housing is dramatically illustrated by a series of natural color photos. Proof that any motor bearing breathes air and therefore leads to contamination of the bearing is photographically demonstrated to indicate the necessity of lubrication every year or so. Excerpts of statements by leading bearing manufacturers about the necessity of motor lubrication are presented. This informative educational booklet, edited by lubrication engineers, is full of startling facts you should know. Write today for a complimentary copy. Simply fill in the Coupon below.

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WITH OUR READERS

Continued from page 5

harmful restrictions. Welding could save consumers hundreds of millions of dollars yearly in lower cost and would make possible a tremendous number of other structures now eliminated by these impractical and unscientific rules."

POWER GETS AROUND . . .

"I see you folks claim that tests indicate the average reader spends slightly more than two hours with each issue of POWER. Well, maybe so, but it takes me most of the month to read one issue. After that my copy passes through four or five hands in my department. I guess I'm just a slow reader.

H HOLCOMBE *Los Alamos, N. M.*

OPERATOR'S LICENSES

"We of the NAPE have completed a proposed model engineers' license law, which we feel will apply to all parts of the country. Now we are preparing a proposed 'enabling act' that is simple and concise to help us get it passed by the state legislatures. Our proposed law has information that will help all engineering groups set up regulations to meet local conditions. We'll send this to all our associations throughout the country. There is much to be done and we need help from magazines like POWER.

"We are also preparing an educational program based on examination questions that will qualify engineers to pass the examinations that would be set up under our proposed law. This will help qualify engineers and remove their objection to constructive legislation.

W C STRICKLER, *National President, NAPE, Washington, D. C.*

EDITOR'S NOTE: *For those of you interested in license requirements,* POWER *has 32-page reprint, covering requirements in all 48 states, in U.S. Merchant Marine, and in Canada. Reprints are $1.00 per copy.*

PULSATING COMBUSTION

We POWER editors are always happy when contributors hand us a bouquet for working their material into a finished product to get higher readership. That's how F H Reynst in France wrote to Assistant Editor Howard Kallen, who handled Reynst's article on pulsating combustion in the August issue and who is now working on a second installment for the November issue. Here's the letter:

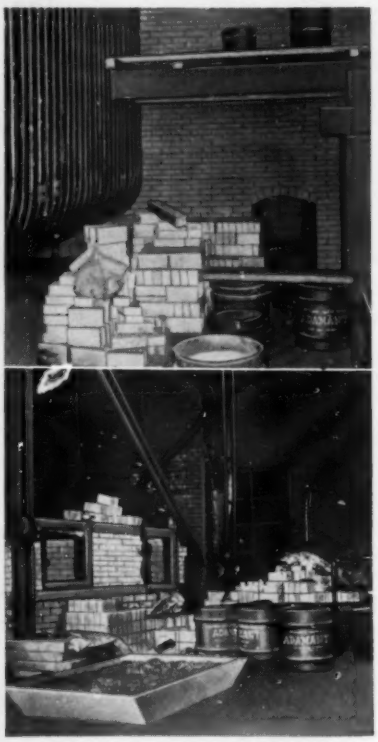
"Let me express my great satisfaction in the way you handled my material. Because you are such a fine stylist, and handled my article so beautifully, I offer you my contributor's check that McGraw Hill is sending me. Too bad the plane fare is so high from Paris to New York. I'd like to sit down with you to work on my second article.

"I feel that pulsating combustion will be big business one of these days. For one thing, I consider these POWER articles more effective than those in scientific papers, brimming over with differential equations."

EDITOR'S NOTE: *Of course we won't accept Reynst's check—we expect to do considerable work on all contributed material.*

(*Continued on page 218*)

AGAIN . . .
THE ONE AND ONLY
ADAMANT FIRE BRICK CEMENT
BEING USED WITH ADAMANT HIGH HEAT DUTY BRICK ON A COMPLETE RE-BRICKING JOB FOR A MAJOR PUBLIC UTILITY COMPANY



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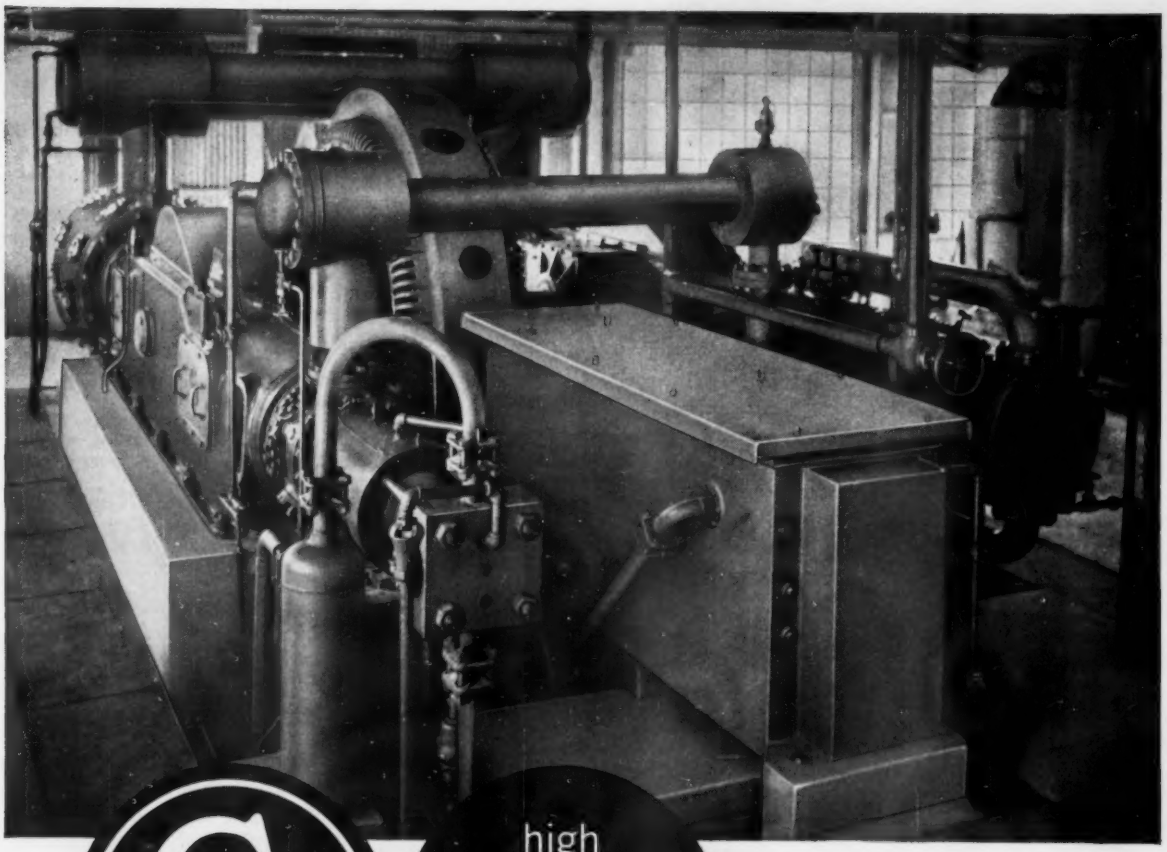

high pressure compressors

A typical CP high pressure compressor installation is this horizontal, four-corner, five-stage compressor delivering gas at 3,000 psig. Intercoolers, with extra-large separators, are machine-mounted, simplifying piping layout. Low compression ratio per stage, low rotative speed and roller bearings assure low power consumption and minimum maintenance expense.

...built to deliver up to 15,000 psig

There's a CP Compressor suited to your special requirements for pressures up to 15,000 psig. They're available in vertical or horizontal, stationary, portable, or semi-portable package types . . . liquid or air cooled . . . manual or automatic capacity control with fixed or variable volume clearance pockets . . . electric motor or steam driven. For information write *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

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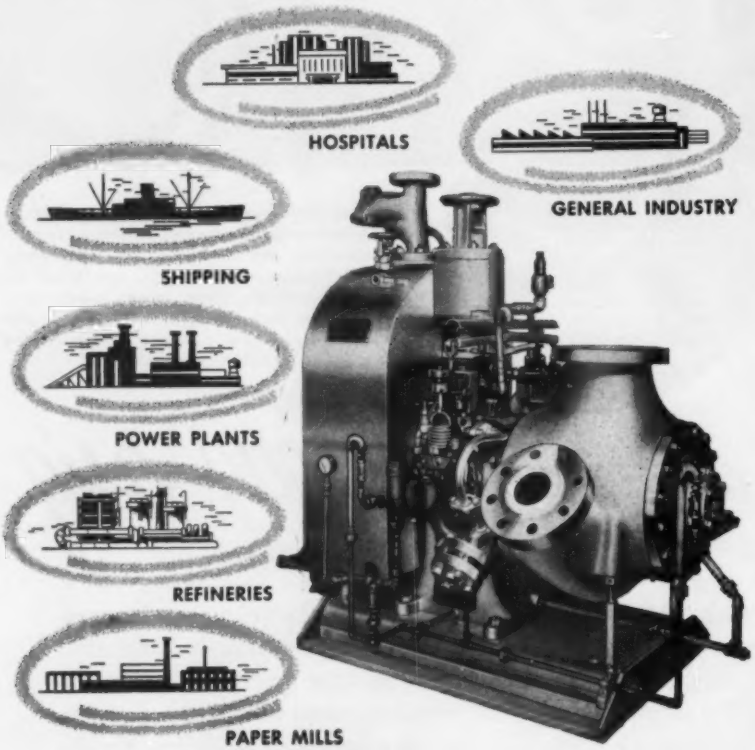

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WITH OUR READERS

Continued from page 216

POWER'S DATA SHEET

Reader Henry Fortier, Jr, of Atlantic Wool Combing Co, Manville, R. I., writes: "In your data sheet No. 263 of May 1954, would the variation in coefficients of expansion 0.000495 per F be of any factor in regard to the table if I used No. 5 fuel oil? If coefficient of expansion is not the same, can you tell me what it is?"

EDITOR'S NOTE: *To amplify data sheet No. 263 for use with No. 5 fuel oil, an average coefficient of expansion would be 0.00035. This is for fuel oils of 0 to 14.9 API gravity.*

Also, the formula listed in Data Sheet No 263 should read, in part, 1 + C instead of 1 – C. Using this correct formula with the above coefficient of expansion, will give answers close enough for most engineering estimates.

We've made an estimate here because we don't know the exact API gravity number of reader Fortier's No. 5 fuel oil.

For further information see ASTM Standard Number D-1250 in ASTM-IP Petroleum Measurement Table No. 6. You might also be interested in Petroleum Measurement Table No. 7. These can be secured for a nominal fee from the ASTM.

More PLANT PROBLEMS

Begins on page 142

Boiler furnaces (from p 144)

sign or fabricate safety devices. Let the control manufacturer do that. He has the know-how and skill.

D R CHRISTENSEN *Des Moines*

INTERLOCK motor- or steam-driven auxiliaries for a prescheduled sequence of starting and stopping. With pulverized coal the sequence should be i-d fan, f-d fan, pulverizer exhauster, pulverizer and pulverizer feeder. Of course, the pulverizer interlocks are unnecessary with gas firing. Use of interlocks insures failure of any motor will cause immediate stoppage of equipment behind it.

When two or more boilers of *EK's* size operate in parallel, selective interlocking is needed. For example, with only one i-d fan operating, it may be desirable to run only one f-d fan. With one of two f-d fans running, it may be desirable to operate only two of three pulverizers.

Alternate scheme limits output of f-d fans and mills to that which can be handled by one i-d fan. This requires interlocking to apply limitations to the combustion-control system. Limits may be obtained by restricting damper opening, preventing maximum fan speeds or throttling coal fed to pulverizer. Variations are obtained with motor-speed regulation, hydraulic or electric couplings. With dual firing, as in *EK's* plant, cutoff or load-limiting control should follow f-d fan operation.

Allow equipment ahead of discon-

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ELIMINATES costly fluid losses

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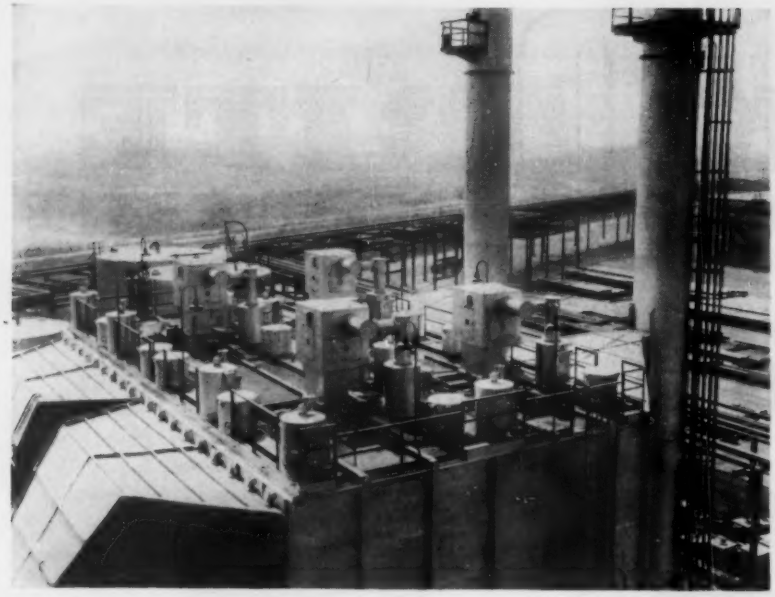

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More PLANT PROBLEMS

Begins on page 142

nected machine to run until it is stopped manually. This permits boiler furnace to be scavenged and a new start made with minimum delay. Push buttons or other switches are helpful to bypass interlocks during disconnects and tests.

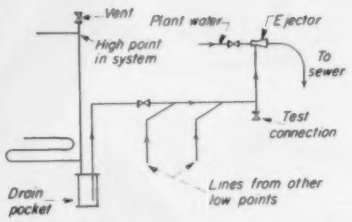
Best scheme of controls eliminates automatic restarting of equipment cut out during trouble periods. I-d fans may start automatically after motor voltage failure, but the other auxiliaries should be manually restarted by the operator of the plant.

H B WAYNE *Brooklyn, N. Y.*

Other readers sending good answers, for which we lacked space, are:

G ROSEKILLY *San Mateo, Calif.*
MELVIN EVANS *Minneapolis, Minn.*
C G HOWARTER *Canton, Ill.*
JAMES SMITHWICK *Washington, D. C.*
HOWARD HOLCOMBE *Los Alamos, N. M.*

Coil freezes **(from p 146)**



USE EJECTOR like that in sketch to remove water from low points in coils. Connect suction to system low points, using one shutoff valve in each branch.

To operate, first open vent valve and then valve in branch to coil being drained. Most of the water in the coil will drain by gravity. When flow stops, run ejector until coil is completely drained. Close suction valve before stopping ejector. Use test valve to see if any water is left in suction line. If there is, use ejector again. It operates with either steam or water.

ANTONIO DI LORENZO *Brooklyn, N. Y.*

FREEZE-UP SWITCHES in fan discharge can be set to stop unit when temperature goes below a safe level. Or return-air controls can be set to limit moisture temperature to a safe level.

Many coils freeze when unit is shut down and dampers are assumed to be tightly closed. Control failure or damper leakage allows cold air to enter compartment and freeze coils. Inspect dampers to see they are tightly closed. Leave inspection doors open so warmer room air can circulate around coils.

Use a high-pressure industrial-type blower to dry coil interior. Run blower

TORTURE CHAMBER

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Here, steam up to 1500 pounds pressure and 1000° F. gives Vogt the answer to any question of materials or construction for valves and fittings in just a few days . . . facts that would take years to obtain under normal operating conditions!

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Thus, by constant and accelerated testing, we quickly and definitely prove or disprove the claims that are made for many newly developed materials. And thereby we make sure that only the best goes into valves and fittings that bear the name Vogt.

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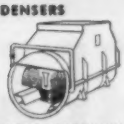
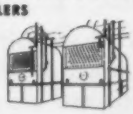
CONDENSERS

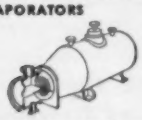


HEAT EXCHANGERS

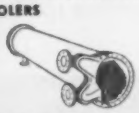
BOILERS



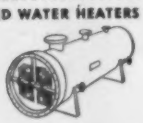
EVAPORATORS



COOLERS



FEED WATER HEATERS



Here is a tube rolling method that outdates all others! Recognizing the long standing fact that air provides the best method of operation, this principle is now combined with positive electrical control. Result: 1) tube rolling is substantially speeded up; 2) human error is eliminated; 3) both ferrous and non-ferrous tubes can be rolled in all sizes from ¼" to 4"—*using only one control.*

The "John Crane" Electro-Pneumatic Tube Rolling Control assures the correct amount of tube expansion into the sheet to provide the exact holding strength and tightness required by the service. "Weepers" or "leakers" are eliminated. "Cold work" stress is minimized. Distortion or fracture of tube sheet ligaments is prevented. *A skilled operator is not required.*

See the new "John Crane" Electro-Pneumatic Tube Rolling Control in action on your own operation. Without obligation to you, we will arrange for a demonstration in your plant. Contact us today. Request 8-page illustrated catalog.

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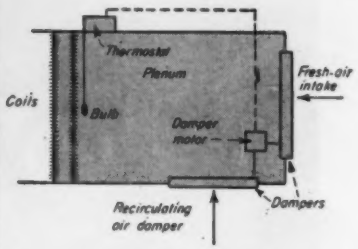
JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

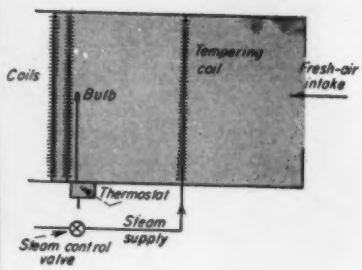
More PLANT PROBLEMS

Begins on page 142

for at least 30 min. Check coil for dryness by holding a mirror at outlet. If it fogs, there is still water in the coil. Continue drying until all moisture is removed from the coil.

E F WEHLAGE *Fairport, N. Y.*





FREEZING results from inadequate design. In the original installation, provision should have been made to protect coils from exposure to freezing air. Now that system is installed there are two possible corrections, but enough space must be available if they are to be used.

A recirculating air damper and intake-air damper in plenum chamber ahead of cooling unit, as in top sketch, is one answer. Link dampers together and control damper motor from a thermostat having a bulb on coil surface. Set thermostat so recirculating air damper opens if air temperature at coil goes below 35 F. Fresh-air damper will close while recirculating damper opens. Proportion dampers and adjust damper motor to maintain minimum required fresh-air intake. Be sure plenum is large enough to permit mixing of the air streams without power waste.

In another method, bottom sketch, an effective hookup can be made if recirculated air must be kept at a minimum. Here a tempering coil in fresh-air intake ahead of cooling coil maintains air temperature at 35 F. This coil must have enough heating capacity to handle maximum system capacity at the minimum outdoor temperature expected. *SP* should control the steam valve thermostatically to maintain desired 35 F. A nonfreeze type coil may be required for the system.

TED THRING *Toronto, Canada*

(*Continued on page* 224)

Unloading 1200-TON BARGES

in less than 90 minutes

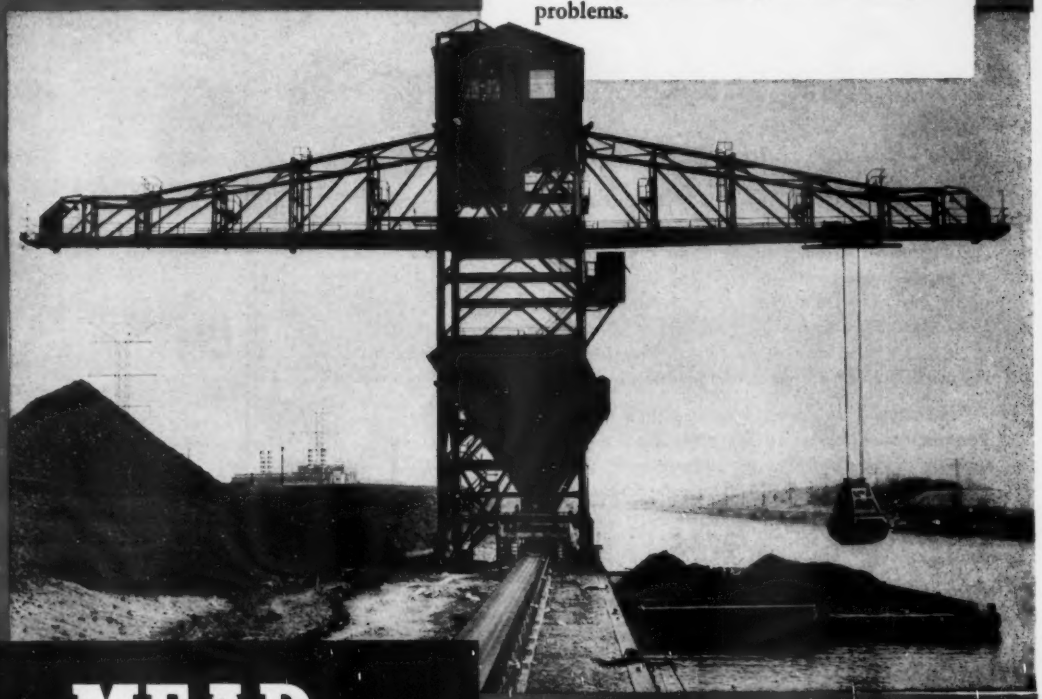
(including clean-up)

This new Mead-Morrison 10-ton stationary coal tower, recently installed at Commonwealth Edison Company's Ridgeland Station, was designed for a free digging rate in excess of 1200 tons per hour from barge to hopper.

The use of a Mead-Morrison lightweight coal grab and a Mead-Morrison barge haul system contributes to this outstanding performance.

One of the features of this machine is an extended cantilever at the rear, allowing coal to be put in storage and to be reclaimed from storage to conveyer belt or barge. Power to the hoist drums is supplied by wound-rotor motors and counter-torque, full-magnetic, reversing, alternating current control for 4160 volts.

Mead-Morrison Coal and Ore Handling Bridges and Unloading Towers are available in capacities up to 2000 tons per hour. They have proven their efficiency and dependability for over 50 years in installations all over the world. Be sure to consult Mead-Morrison on your material unloading and rehandling problems.



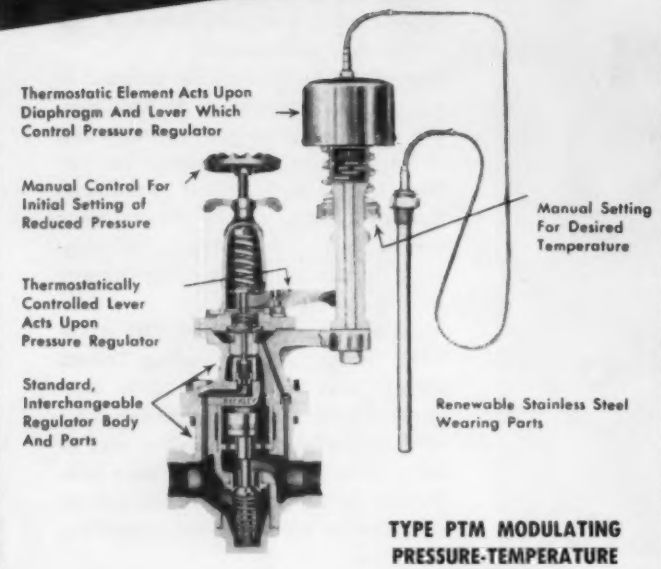
MEAD-MORRISON

Division of
McKIERNAN-TERRY CORPORATION
Manufacturing Engineers
HARRISON, N. J.

THIS NEW KECKLEY REGULATING VALVE GIVES

Finer Temperature Control

THAN EVER BEFORE POSSIBLE!


Thermostatic Element Acts Upon Diaphragm And Lever Which Control Pressure Regulator
Manual Control For Initial Setting of Reduced Pressure
Thermostatically Controlled Lever Acts Upon Pressure Regulator
Standard, Interchangeable Regulator Body And Parts
Manual Setting For Desired Temperature
Renewable Stainless Steel Wearing Parts

TYPE PTM MODULATING PRESSURE-TEMPERATURE REGULATOR

Costs No More Than Less Sensitive Separate Units

The new Keckley Type PTM modulating pressure-temperature regulator establishes a new standard of accuracy of temperature regulation for batch processing, air ducts and other exacting control jobs. As temperature tends to vary, the thermostatic control unit acts upon the pressure regulator to reduce or increase steam pressure. Pressure will modulate smoothly and rapidly between the initial setting and zero, thereby preventing overrun. Rate of pressure modulation is adjustable, giving the user a wide choice of control.

This new valve costs no more than separate Pressure and Temperature Regulators but gives much finer control and a simpler installation. Originally developed to meet exacting TVA specifications, Type PTM is a refinement upon earlier Keckley types, which are still catalogued for average requirements.

Ask for your copy of the new Catalog 54-A describing the complete Keckley line of Steam and Liquid Control Equipment.

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Diaphragm Valves • Safety and Relief Valves • Solenoid Valves

More PLANT PROBLEMS

Begins on page 142

LARGE INSTALLATONS use a heat exchanger to keep water temperature between 35 and 50 F, depending on outside temperature. A circulating pump starts automatically whenever outdoor temperature reaches 35 F. Water is kept in the system summer and winter, permitting starts at any time.

Suitable chemical treatment keeps corrosion low at all times. This method is cheaper than an antifreeze and allows easy tie-in of new units to existing ones.

SP can reduce and prevent freezeups by checking for sediment accumulation, which slows circulation. This is especially important when coil return piping runs up to the return riser. Check return-air system and its dampers to see it runs properly and gives the desired mixture in the system.

L W FITZPATRICK
Jefferson City, Mo.

VACUUM PUMP, rated to 29.9 in. Hg, would be suitable for drying out any moisture that cannot be drained. Or use a blower to circulate warm air through the coil. Remove moisture from air with a silica-gel drier.

J L AIKMAN *Nicosia, Cyprus*

Other readers sending good answers, for which we lacked space, are:

GORDON ROBB *Chalk River, Ont.*
W J STEINERT *Flushing, N. Y.*
L M MARTINEZ *Rego Park, N. Y.*
A J BREUGELMANS *New York, N. Y.*
J SMITHWICK *Washington, D.C.*
A M PALMER *Brooklyn, N. Y.*
OBENO CUOGHI *Richmond Hill, N. Y.*
JERRY TRNCAK *Houston, Texas*
C G HOWARTER *Canton, Ill.*

FEEDWATER

Continued from page 113

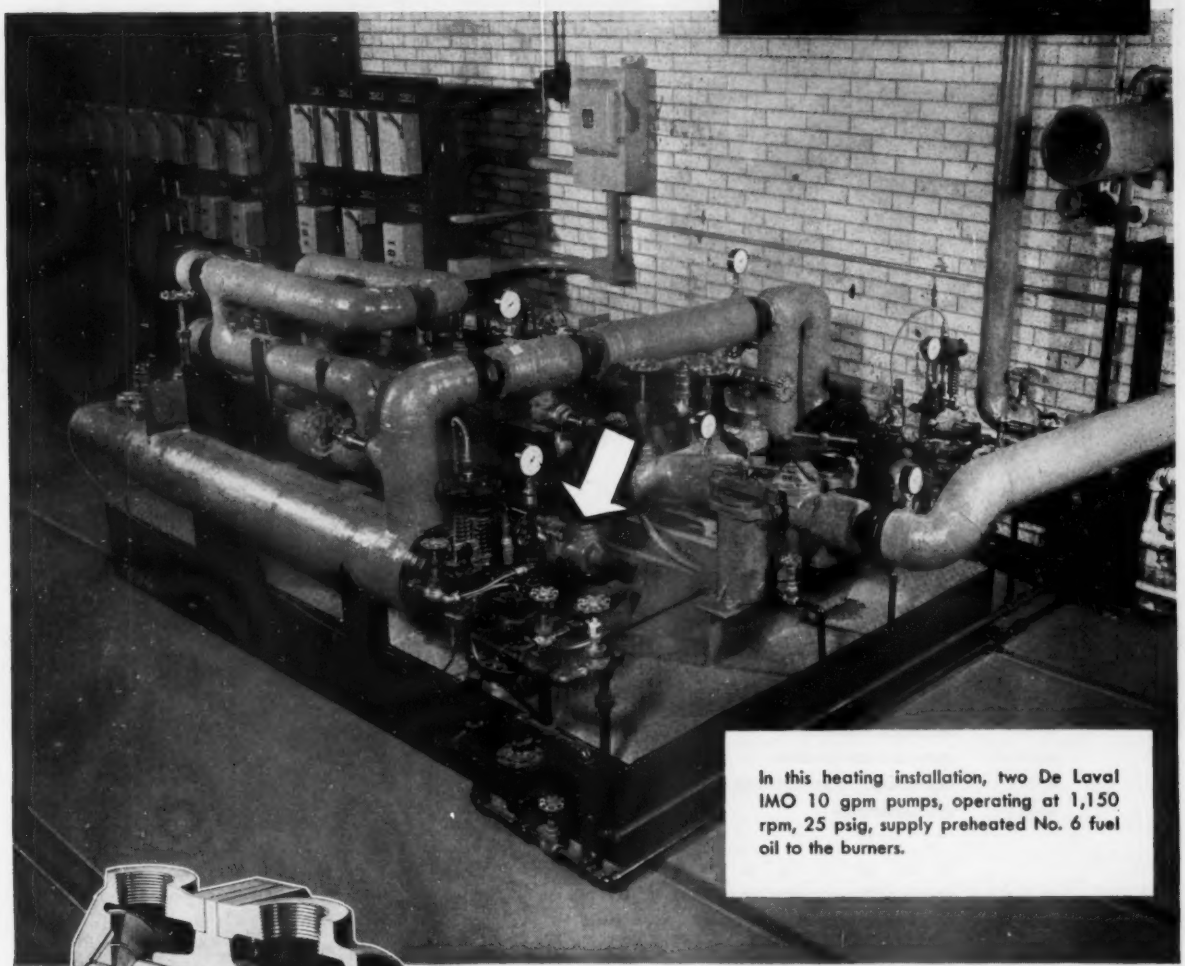
precipitates. Whether these particles have a strong tendency to adhere to zeolite should be determined. And there is evidence that this characteristic varies seasonally.

As the zeolite softener in a filterless plant serves also as a filter, turbidity to the softener should be kept as low as possible. The hot-process unit acts as a clarifier as well as a softener. And to get best results, it must be designed for maximum settling area. It is good practice to eliminate surges in the hot-process unit by providing separate or integrated backwash storage facilities.

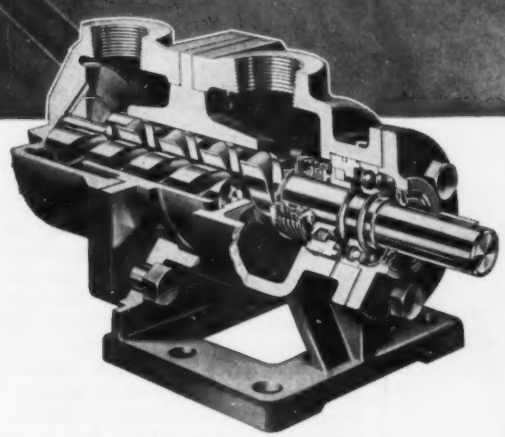
Flow requirements through the hot-process softener increase when zeolite rinse water is needed. It is important to consider this on the original design. The rinse takes 20 minutes at the rate of 4-6 gpm per sq ft per zeolite softener.

Contracts are more profitable when you install dependable

DE LAVAL
IMO PUMPS



In this heating installation, two De Laval IMO 10 gpm pumps, operating at 1,150 rpm, 25 psig, supply preheated No. 6 fuel oil to the burners.



A wide range of De Laval IMO models specifically built for fuel oil service is available. Capacities up to 80 gpm, pressures to 275 psig. Write today for Bulletin LG-A.

To increase your present—and future—profits on commercial heating jobs, install *dependable* De Laval IMO pumps on pump and heater sets. Their simple, trouble-free design saves you money on service calls. . . builds customer goodwill, for there's nothing to get out of order or need adjustment. No pilot gears, no sliding vanes, no reciprocating pistons. De Laval IMO's have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

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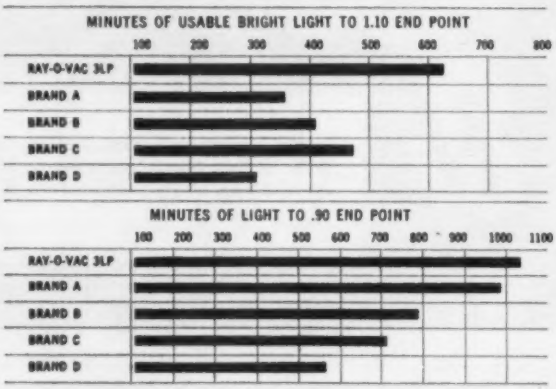
DL272

newest and finest!

Industrial Flashlight Battery

Here are amazing comparative*performance figures!



Here's a truly new, *performance-tested* Industrial Flashlight Battery! Available now in the famous patented Ray-O-Vac sealed-in-steel construction . . . and at no extra cost! Here's a battery that *always* gives longer usable light time! Like all Ray-O-Vac LEAK PROOF Brand batteries the No. 3LP is fully guaranteed against corrosion because it's sealed in steel—top, bottom *and* sides.

RAY-O-VAC COMPANY

*Figures obtained from tests conducted under specifications established in Circular of National Bureau of Standards No. C-466.

ARGUMENTS

Continued from page 148

Additional services (continued)

size. Prices may be obtained from manufacturers and the most economical unit chosen.

With regard to the list of services requiring emergency power, air supply for the sprinkler systems has been listed. If sprinkler-water pumps are tied to the plant power system, install provision for them, too. The item on air for stokers indicates boiler operation is to be maintained. I believe emergency power should be available for boiler feed pumps, stoker drives, fans, motor-operated valves, coal-handling equipment.

Tanasi mentions cafeteria refrigeration, which suggests that emergency period may be lengthy. If so, consider building heating requirements needing electric power for solenoid valves, condensate pumps, unit heater fan motors and controls.

Emergency power for air conditioning is desirable although not essential.

H B WAYNE *Brooklyn, N. Y.*

Emergency circuits (continued)

If boiler capacity is adequate, by all means use a steam turbine-generator. It is simpler, faster to get into service, and depreciation is less.

Otherwise, use either a gasoline- or a diesel-electric generating set. Either starts quickly and handles the load without trouble.

One problem is that there must be some way to separate the emergency circuits from the others. In an emergency the main load must be dropped and only the essential ones left connected. If the total load is imposed on the emergency set, it acts somewhat like a short circuit and opens the circuit breakers, or stalls the set.

E A ROBERTS *Carlsbad, N. Mex.*

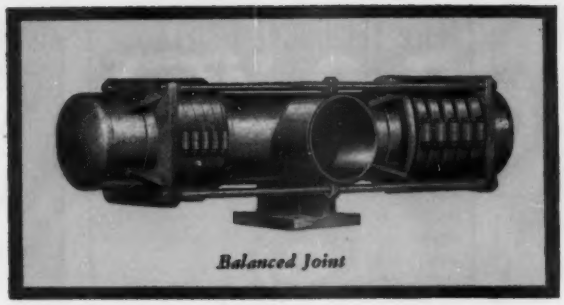
User must decide whether diesel or gas is better

WHETHER Tanasi (June "Arguments") uses diesel or gas depends entirely on his individual opinion. Either will do the job, and operation can be entirely automatic, semi-automatic or manually controlled. The simpler the setup and the fewer the gadgets, the better.

Best procedure is to buy a standard product made by a recognized manufacturer, making sure he knows the requirements. Follow standard installation and operation procedure.

In addition to the emergency services listed, I think one might well consider a motor-driven pump for emergency water service.

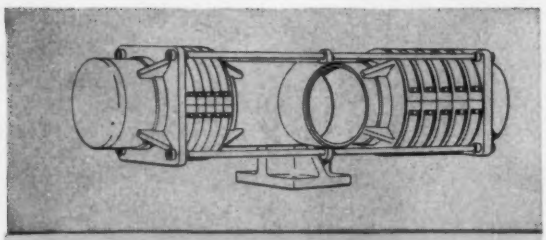
CLYDE HOWARTER *Canton, Ill.*



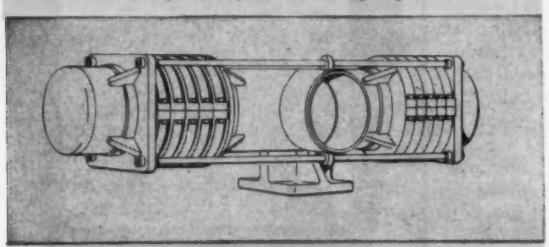
Balanced Joint

ELIMINATE END THRUST AT PIPE INTERSECTIONS . . . . .

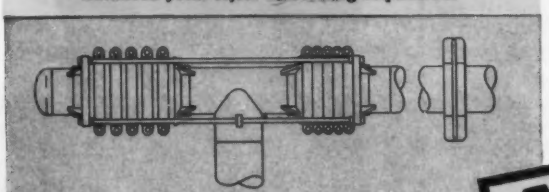
THE *Corruflex* BALANCED JOINT



Balanced Joint Before Absorbing Expansion.



Balanced Joint After Absorbing Expansion.



When pipeline is in service, element absorbing expansion is compressed; other is extended.

• Buying an expansion joint from ADSCO is like shopping in a super-market. Everything you need is under one roof. Offering the world's most complete line of both slip and packless expansion joints, ADSCO is the only manufacturer able to supply the right joint for every purpose. ADSCO's complete line is backed up by an engineering service which since 1877 has found exact solutions to customers' special problems.

An example of ADSCO's versatility is the Corruflex Balanced Joint illustrated here. This packless expansion joint is designed to accommodate axial motion and eliminate end thrust at pipe intersections. The rods tie the joint ends together, thereby transmitting the end thrust to a distant point where adequate anchorage is available. The joint thus requires only the equivalent of an intermediate or stabilizing anchor.

So when you're shopping for expansion joints, come to ADSCO first. You won't have to look elsewhere . . . Call your ADSCO representative or write for Bulletin 35-51A.

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More TECHNICAL BRIEFS

Begins on page 162

generating-equipment design is based on much field experience with older units, together with laboratory data obtained on a large selection of materials, and scientific information from experiments. It is remarkable how much the designers of older units accomplished with so little to work with.

Considering materials and experience available to the designer today, and the vast body of operating experience, it does not seem unreasonable to expect useful life of modern hydroelectric units to be 100 years or more.

Today's generating units may operate satisfactorily throughout useful life of the dam, provided that factors reducing or eliminating cavitation, erosion, and other causes of destructive action, are carefully considered in the original design of the power plant. Cost of lost revenue and labor, caused by frequent repair over a period of 100 years or more, could greatly exceed the extra cost of a lower turbine setting, a lower specific speed, or cost of erosion- and corrosion-resistant material.

Governor components discussed include speed-responsive element, flyball drive, dashpot, speed-droop mechanism, speed-level control, gate-limiting device, relay valve, piping, oil pump, etc. *ASME paper No. 54-F-17.*

Economical turbine design for marginal hydroelectric plants. *By A R Klann, Allis-Chalmers Manufacturing Co.*

With the advent of large hydroelectric and thermal plants tying into extensive networks, many potential hydro sites remain undeveloped because they are marginal in nature and cannot be developed economically along standard lines. In other instances, water-power sites developed years ago are becoming costly to run because of antiquated equipment but may not be abandoned.

In the face of such problems, steps must be taken to reduce capital and operating costs in order to utilize many of these marginal sources of hydroelectric power.

Although conventional designs of turbines and auxiliary equipment are too costly for many of these plants, numerous practical modifications can be made to reduce initial cost without sacrificing reliability or long life. Few of these modifications represent recent development but with the trend toward high unit capacities for ever-larger projects, less attention has been given to development and rehabilitation of small- and medium-capacity sites which could produce many kwhr per year.

Utilization of economical designs dis-

Directions for ordering papers on p 232

WALWORTH VALVES on the job in power plants

A prominent electric company* in Massachusetts specified Walworth Pressure-Seal Gate Valves for high-pressure, high-temperature steam lines. The patented bonnet joint of Walworth Pressure-Seal Valves — no bonnet flanges, bolts, or welds — makes them ideal for this type of service, especially where there are space and weight limitations.

Additional information on Walworth Valves and Fittings for power plants may be obtained, with no obligation to you, by writing to Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.

*Name on request

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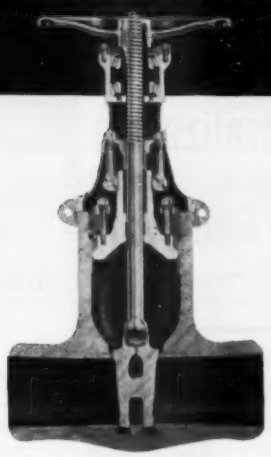
PRESSURE-SEAL CAST STEEL VALVES

Better because ... **They have no bonnet flanges, bonnet bolts, or bonnet welds. Ideal for high-pressure, high-temperature steam service and corresponding boiler feed service, Walworth Pressure-Seal Cast Steel Valves weigh less, and take up less space than the flanged bonnet type of valves used for similar services.**

These are a few of the important advantages made possible by the design of Walworth *Pressure-Seal* Cast Steel Valves. Internal line pressure is utilized within the bonnet to maintain a tight, leakproof, body-to-bonnet connection under all normal operating conditions. The higher the pressure, the tighter the seal.

Ask for your copy of Walworth Circular 143. It gives detailed information, including sizes, dimensions, and specifications for all Walworth Pressure-Seal Cast Steel Valves.



Cross section of 8-inch Series 900 Walworth Pressure-Seal Cast Steel Gate Valve. Pressure-Seal Globe, Check, Angle, and Non-Return Valves are also available in Series 600, 900, 1500 and 2500 in a wide range of sizes.

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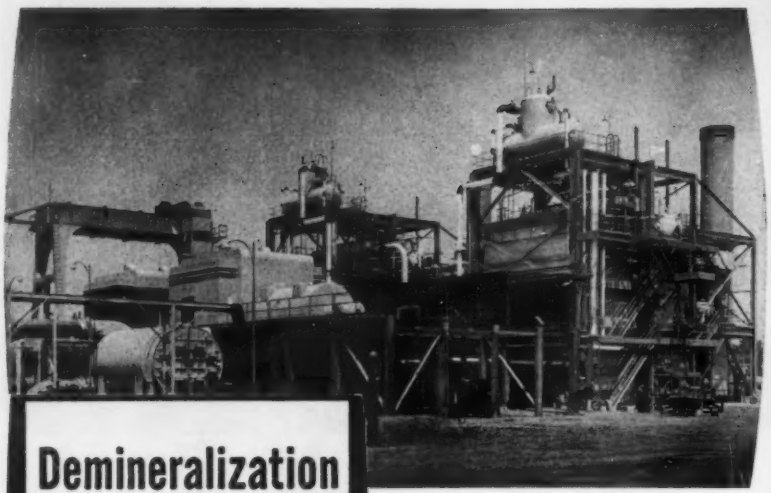

Demineralization *and* **Silica Removal** *equipment...* *in the above plant*

is so small it can hardly be seen in this picture—yet the CATEXER® and ANEXER® ion exchangers provide the low silica, low solids boiler feed makeup water required for trouble-free high pressure boiler and turbine operation.

For more information, write for INFILCO Ion Exchanger Bulletin 1960-K.

Send for this useful bulletin —no obligation

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More TECHNICAL BRIEFS

Begins on page 162

cussed in the paper, together with other cost-reducing arrangements in building construction, generating and automatic control equipment, can result in profitable investments. Many utilities find such reconsiderations worthwhile. *ASME paper No. 54-F-16.*

Heat transfer

Use of numerical analysis in transient solution of two-dimensional heat-transfer problems with natural and forced convection. *By S K Hellman, George Habetler and Harold Babrov, Knolls Atomic Power Laboratory, General Electric Company.*

To determine stresses in a nuclear reactor during power buildup and decay, a method of evaluating transient temperatures involved must be derived. This paper presents an analysis of a two-dimensional metallic structure containing many flow channels. Cooling is accomplished through natural and forced convection.

Heat generation and conduction are considered as functions of time and two space variables. Laminar motion of the liquid metal is expressed by means of transient, one-dimensional flow-rate equations, derived from Euler's equation. The system is set up as a thermal network so resulting finite-difference equations can be solved by a digital computer. *ASME paper No. 54-SA-53.*

A test loop for determining heat-transfer coefficients by the thermal-cyclic method. *By L S Mims and J A Kleber, Atomic Power Div, Westinghouse Electric Corp.*

The thermal-cyclic method has two important advantages over the steady-state method of measuring convective film coefficients of surfaces with odd physical shapes. Steady-state method requires that heat be made to flow continuously from solid to the fluid; it also requires that metal surface temperature be known.

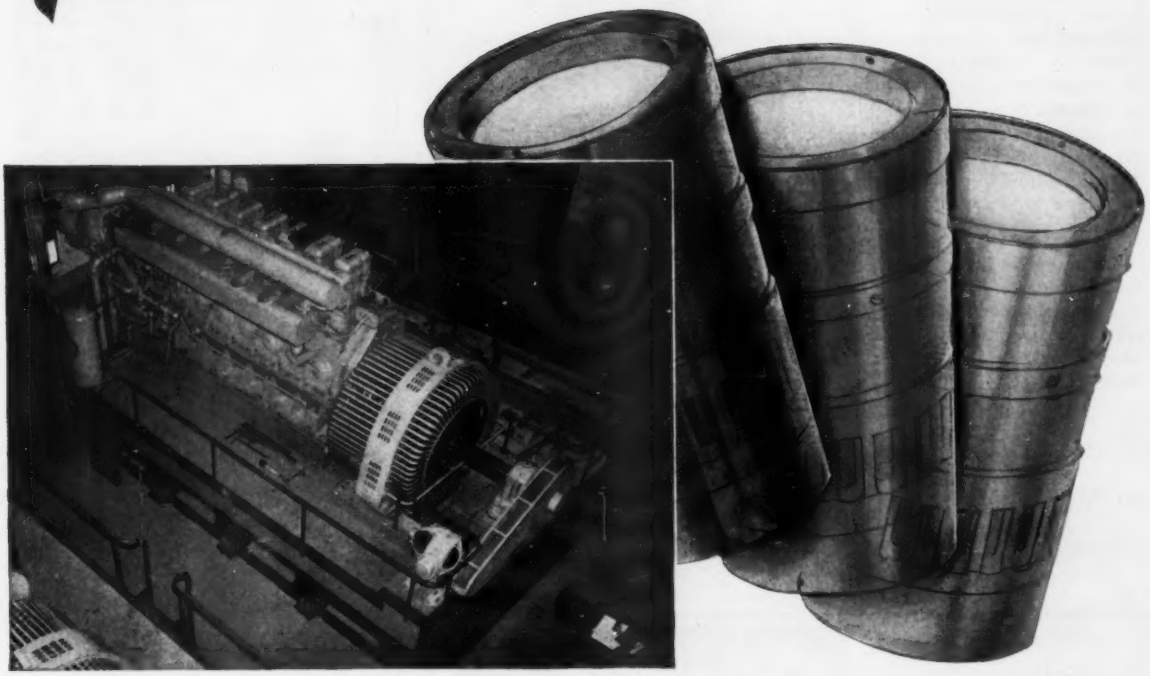
Both these disadvantages are eliminated in the thermal-cyclic method where heat is applied directly to fluid and in which only temperatures of fluid inlet and outlet at the test section need be recorded.

The Westinghouse Atomic Division has constructed a loop operating on the thermal-cyclic principle. This loop, using water as fluid, was designed to operate in a range suitable to the cyclic-measuring theory.

Test data obtained show good correlation with the Colburn equation and the thermal-cyclic method has proved

Directions for ordering papers on p 232

Full-Throttle Profit...



Want to open the throttle for more profit? Then throttle back on Diesel operating costs — by using Van der Horst processing.

It gives you a flexible advantage. With VANDERLOY M, we renew worn liners — even those that oversize 0.010 inch per inch of diameter. Finished to original dimensions with PORUS-KROME*, they'll take twice the punishment raw liners can stand.

Yet, as compared to buying new ones, these Van der Horst liners save you money!

Use them to boost the power factor without increase in cost, or take the profit on their higher efficiency and much longer service life — whichever way fits best in your operating pattern.

Diesel owners everywhere find PORUS-KROME out-wears two or more raw liners. Rings stand up proportionately longer, against this unique plated service. And both fuel and lube oil consumption are reduced.

You might as well have this advantage. Cut out the cumulative cost of oversizing and use only standard size parts. Once you've tried it, you'll find Van der Horst processing is the way to full-throttle profit. We'd like to show you, in actual figures.

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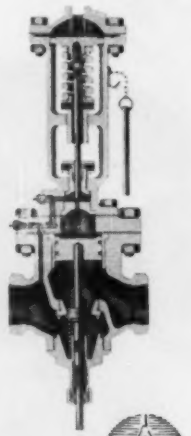

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Begins on page 162

a useful tool in obtaining heat-transfer data. A possible future use may be to measure the effect of film deposits on heat-transfer coefficients. *ASME paper No. 54-SA-48.*

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TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from sources, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Power Conference, annual meeting, Sherman Hotel, Chicago, Ill., Mar. 24-26, 1954. Identified by initials APC. Obtainable in proceedings that may be purchased from R A Budenholzer, chairman, Illinois Institute of Technology, 3300 Federal St, Chicago 16, Illinois.

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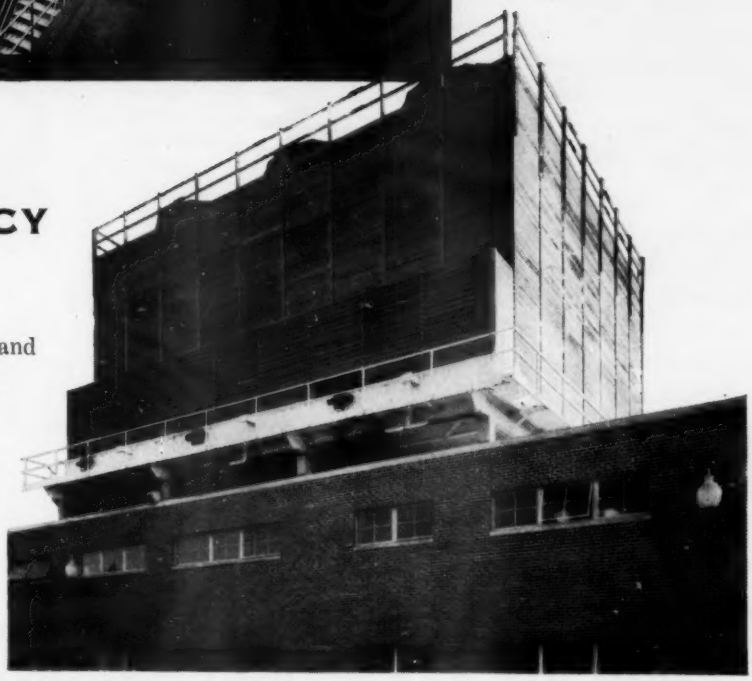

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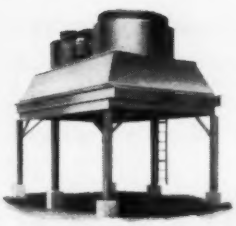

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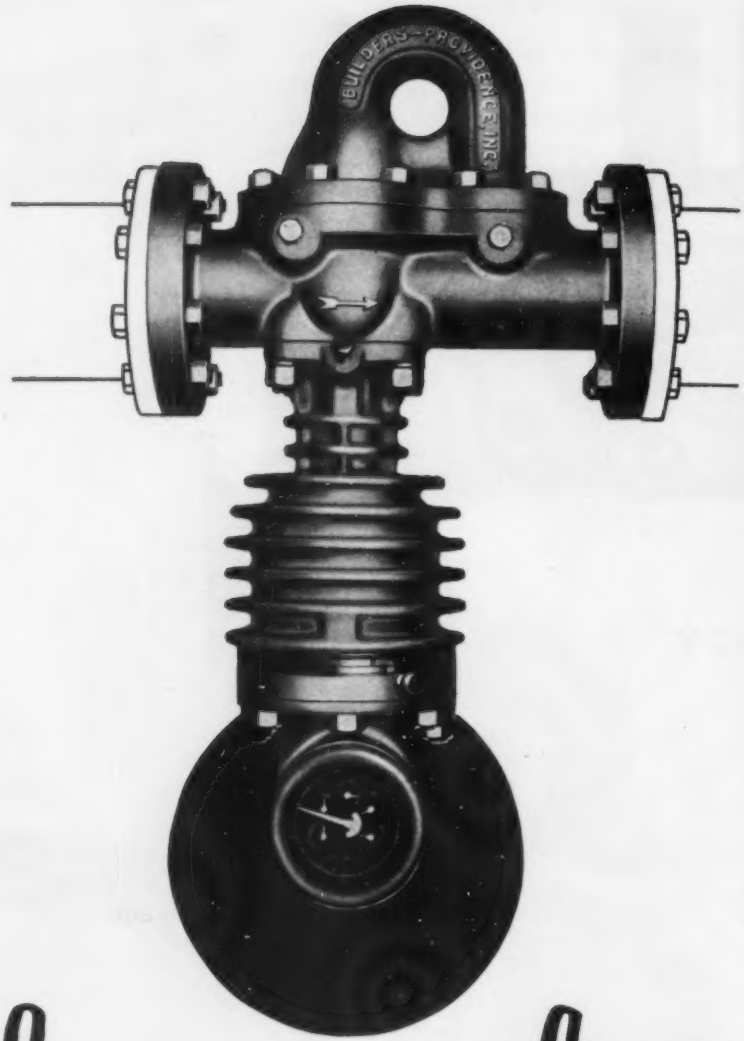

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18 **Thermostatic temperature** regulators, *Type S*. Applications, photos, diagrams and specs in 12-page bulletin S-8. Lawler Automatic Controls, Inc, 453 N MacQuesten Pkwy, Mt Vernon, New York.

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22 **Electric equipment.** Two, 8-page bulletins, GEA-6195 on electric equipment for heavy construction tools and GEA-6196 on installed equipment for heavy construction projects. Specify bulletin desired. General Electric Co, Schnectady 5, N. Y.

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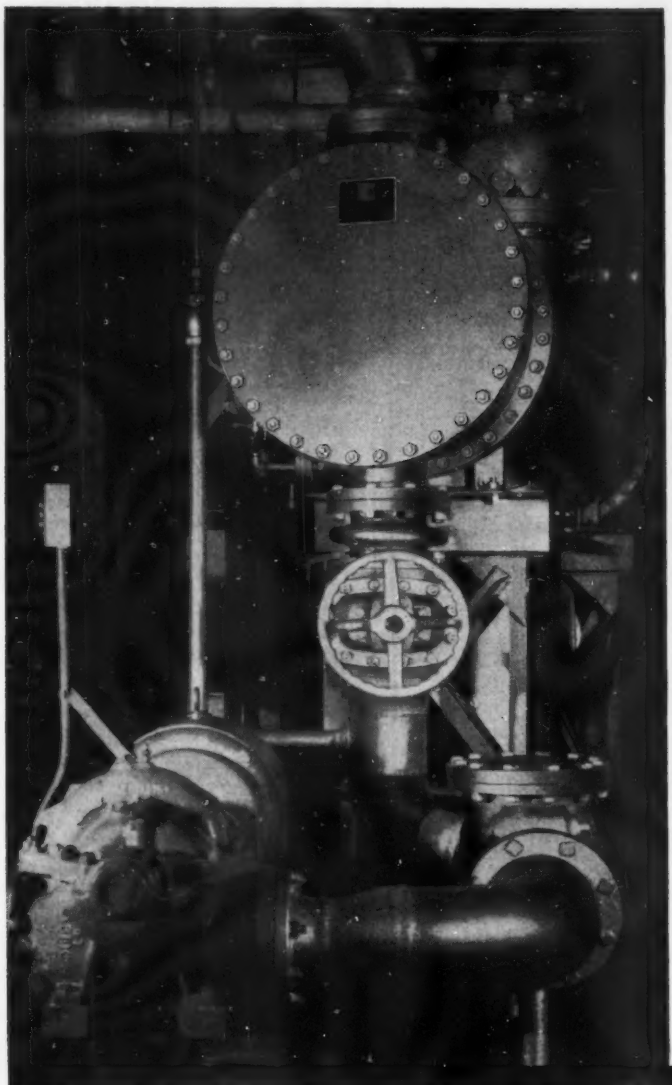

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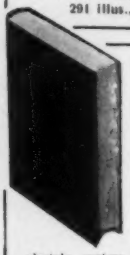

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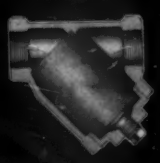

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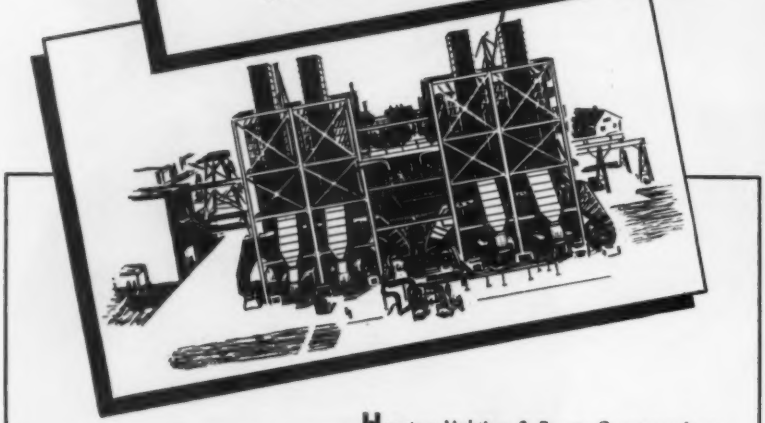

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51 **Photoelectric** and electronic measuring instruments. Illustrated, 4-page bulletin 100 contains data on complete line. Photovolt Corp, 95 Madison Ave, New York 16, N. Y.

52 **Limit controller** automatically shuts off fuel supply at any specified temperature. Photo, diagram, ranges in 2-page bulletin F-6313. Wheelco Instruments Div, Barber-Colman Co, Rockford, Illinois.

53 **Flow meters.** 58-page catalog 2320 describes all types: indicating, recording instruments of both evenly graduated and square root types. Included are area meters and differential converters. Minneapolis - Honeywell Regulator Co, Industrial Div, station 64, Wayne & Windrim Aves, Philadelphia 44, Pa.

54 **Measurement and control** of steam and gases. Illustrated 4-page bulletin 5001, explains applications, operation principles, specs of *Critiflo-Meter*. King Engineering Corp, Box 610, Ann Arbor, Michigan.

55 **Composite Catalog** 5001 contains brief descriptions of all Brown Instruments including potentiometers, thermometers, pressure gages, level meters and panelboards. Minneapolis-Honeywell Regulator Co, Industrial Div, station 64, Wayne & Windrim Aves, Philadelphia 44, Pa.

56 **Liquid and gas controls,** 36-page bulletin 004. Illustrates controllers, gages, manometers, recorders, meters, valves, Venturis and others applicable in water, power and processing. Simplex Valve and Meter Co, 68th and Upland St, Philadelphia 42, Pa.

57 **Steam generation instrumentation,** bulletin 9050, 30-page illustrated bulletin dealing with flow meters, liquid level recorders, thermographs, pressure gages and other instruments. Minneapolis-Honeywell Regulator Co, Industrial Div, station 64, Wayne & Windrim Aves, Philadelphia 44, Pa.

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58 **Hand threading** stainless steel pipe and tubing. Informative bulletin discusses die stock, dies, speed, cutting oils and assembly. Four-page bulletin TDC-147. The Babcock & Wilcox Co, Tubular Products Div, Beaver Falls, Pa.

59 **Pipe markings** and identification labels. Eight-page bulletin with complete list of markings. North Shore Nameplate, Inc, Bank of Manhattan Bldg, Bayside, Long Island, New York.

60 **Valves** for applications on pressures of 15 to 400 psi. *Flowtrol* valve can be used any place a globe, angle, plug or gate valve is used. Diagrams, specs in 8-page bulletin W8-A. Golden Anderson Valve Specialty Co, 1244 Ridge Ave, Pittsburgh 33, Pa.

61 **Handle action valve.** Operation, service, installation data, diagrams in 4-page bulletin 307. Ross Operating Valve Co, 120 E Golden Gate Ave, Detroit 3, Michigan.

62 **Solenoid valves,** compact two-way units for controlling flow of gas, water, air, light oil and other noncorrosive fluids. Cutaways, dimensions in 4-page bulletin 8210A, Automatic Switch Co, 391 Lakeside Ave, Orange, N. J.

63 **Globe and angle valves,** *500 Brinell line.* Full details in bulletin 110. Kennedy Valve Manufacturing Co, 1021 E Water St, Elmira, New York.

64 **Twelve-point nut** designed to reduce tool clearances. Engr data, dimensions in 12-page bulletin. National Machine Products Co, Utica, Mich.

(*Continued on page* 240)

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65 **Steel valve** "Technical Tips" bulletin 542. Illustrates and describes data on various valve subjects. Edward Valves Inc, 1201 W 145th St, E Chicago, Indiana.

PRIME MOVERS AND ACCESSORIES

66 **Industrial engines.** Full details on 4-cylinder L and F head designs. Photos, charts and installation diagrams in 6-page bulletin. Industrial Engine Dept, Willys Motors Inc, 1295 N Cove Blvd, Toledo 1, Ohio.

67 **Engines.** Specs, photos and cutaways of complete line of 13-in. bore and 16-in. stroke diesel, gas-diesel and spark-ignited gas engines. Illustrated 15-page bulletin J-73. The Cooper-Bessemer Corp, Mount Vernon, Ohio.

68 **Mechanical drive turbine,** *type YR*, described in 16-page bulletin H-22. Photos, features, specs, dimensions, and modifications. Elliott Co, Jeannette, Pa.

PUMPS

69 **Industrial pumps.** Illustrated 108-page catalog I-54 describes practically every industrial pump made by company. Construction features, performance and selection tables, diagrams. The Deming Co, Salem, Ohio.

70 **Hydraulic pump** develops to 30,000 psi at 90 psi air supply. Design, installation, operation data in illustrated data sheet 36. The Aldrich Pump Co, Allentown, Pa.

WATER TREATMENT

71 **Filming amines** used to control condensate line corrosion. 4-page illustrated technical paper No. 127. W H & L D Betz, Gillingham & Worth Sts, Philadelphia 24, Pa.

72 **Gravity filters** and filter accessories. Specs, diamensions, operating data in illustrated 24-page bulletin 2539B. The Permutit Co, 330 W 42nd St, New York 36, N. Y.

73 **Acidizing service** for water wells. Descriptive data, case histories on service offered. Four-page bulletin. Dowell Inc, Box 536, Tulsa 1, Oklahoma.

74 **Automatic proportioner** for use with company's chlorinator. Flow diagram, cross-section, specs in 2-page bulletin 70-20. Fischer & Porter Co, 160 Jacksonville Rd, Hatboro, Pa.

75 **Technical paper,** "Practical Performance of Water-Conditioning Gadgets." Hall Laboratories Inc, Hagan Bldg, Pittsburgh 30, Pa.

76 **Technical paper,** "Film Forming Corrosion Inhibitors Also Aid Heat Transfer." Four-page bulletin 129. W H & L D Betz, Gillingham & Worth Sts, Philadelphia 24, Pa.

MATERIALS HANDLING

77 **Fork lift trucks.** Complete work kit for applying lift truck standard performance data. The Yale & Towne Manufacturing Co, 11000 Roosevelt Blvd, Philadelphia 15, Pa.

78 **Handling systems** for various types and classes of materials. Illustrated 32-page bulletin 400. Gifford-Wood Co, Hudson, N. Y.

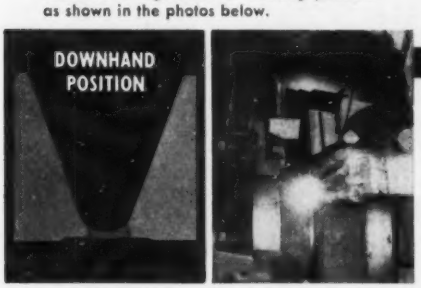
★ **Bulk material handling.** Illustrated 32-page booklet discusses mechanical, electrical and structural features of ore and coal bridges, man trolley unloaders, rope-operated towers, hydraulic buffers, etc. ★Request direct on company letterhead. Dravo Corp, Crane & Bridge Dept, Neville Island, Pittsburgh 25, Pa.

79 **Dryer and cooler** has revolving horizontal drum with fixed diameter solid shell and slotted inner shell with graduated diameter. Tables, operation principles, applicable materials in 20-page bulletin 2511. Link-Belt Co, 307 N Michigan Ave, Chicago 1, Illinois.

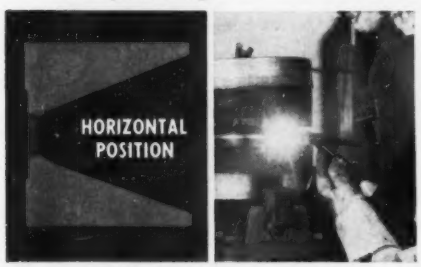
INERT GAS TUNGSTEN ARC-WELDING
ON HIGH-TEMPERATURE, HIGH-PRESSURE PIPING

We've Been Doing It For Years

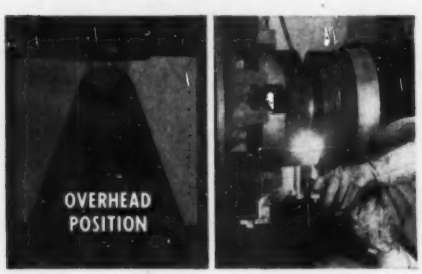
With proper groove design, and "free flow" of inert gas, internal contour of root bead is maintained regardless of welding position as shown in the photos below.

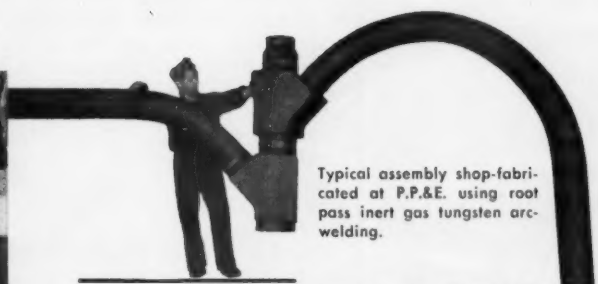


Inert gas tungsten arc root welds, made regularly in P.P.&E.'s laboratories, serve as a check on production procedures, as shown in three photos at right.



Welder's skill is an important factor in obtaining full penetration and fusion with proper internal contour of root bead.





Typical assembly shop-fabricated at P.P.&E. using root pass inert gas tungsten arc-welding.

First pass welding, by the inert gas shielded arc-welding method, is a standard production operation at Pittsburgh Piping. But — simply shielding the internal surface of the root bead with inert gas under "controlled" pressure does not automatically assure a sound joint. The position of welding, welding groove details, and the welder's skill are among the many critical factors.

Pittsburgh Piping's process provides an inert gas shield against the atmosphere on both internal and external surfaces of the root pass. This procedure, combined with other P.P.&E. processes, eliminates need for backing rings and double butt welding, and produces a sound, clean joint having a remarkably uniform root bead of proper contour.

Applicable to all types of power and process piping — inert gas tungsten arc-welding is another of the many techniques which have been thoroughly investigated and checked in P.P.&E. experimental laboratories before being generally used. It has been a successfully-applied production process at Pittsburgh Piping for years.

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PP-6

Washington Water Power Co.
Cabinet Gorge Project
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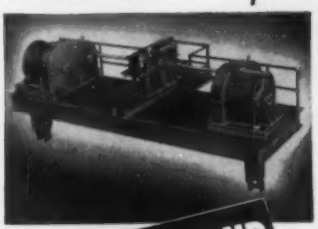
POWER DAM GATES

ask us about design and patterns that may help you . . .



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Backed by over 60 years experience

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for any Size Power Dam

In planning gates or gate hoists, you may save time and money if you will write us before your over-all plans are complete. . . . In over sixty years of designing and building power dam gates and gate hoists, we have developed designs for many gate and gate hoist problems. For that reason, we may have designs and patterns that will fit your special requirements. MURCO gate hoists are designed and built in a wide range of capacities, from less than one ton to over one hundred tons . . . from the smallest hand operated to the largest motor operated gate hoist.

We also build gate hoists to fit your plans and specifications. Write for complete information and Engineering Department recommendations.

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More POWER NEWS

Begins on page 160

atomic energy, as well as review the status and outlook in the United States.

Neils Bohr, famous Danish atomic physicist will be the luncheon speaker on Oct 13. Other principal speakers include: Admiral Alvaro Alberto, Brazil; William Bennett, Canada; and Francis Perrin, France.

Americans on a panel discussing competition with conventional power will include Lawrence Hafstad, AEC; W Kenneth Davis, AEC; F C Gronemeyer, The Fluor Corp; James A Lane, Oak Ridge National Laboratory; and S Untermyer, General Electric Co.

Other sessions will discuss the public safety aspect of reactor location, raw material supply, economic locations for atomic power, industrial uses for radio isotopes, patterns and solar energy.

McNary hydroelectric plant adds 1,000,000-kw to Northwest

► McNary Dam, one of the world's great power plants, was dedicated on Sept 23. Built at an esimated cost of $287 million by U.S. Corp of Engineers, it will add over 1,000,000 kw to the Northwest power pool. Located near Umatilla, Oregon, it is part of the main control plan for comprehensive development of the Columbia River and its tributaries.

The dam has a maximum height of 197 ft, a 1310-ft gate-controlled spillway, a 1422-ft powerhouse, and with earth abutments has total length of 7400 ft. Designed for 1,567,200 hp, project will have fourteen 111,300-hp main generating units and two 4500-hp service units, when operating under 80-ft effective head.

Main turbines are *Kaplan* propeller design with adjustable blades. Operating at 8715 rpm they are world's highest powered units of their type. Each of the five-blade turbine runners is 23-ft in diameter and weighs 212 tons. Five units are in operation and a sixth will go into service this year.

Construction at the dam started in May, 1947 and is scheduled for completion in 1956.

Vienna selected as site of 5th World Power Conference

The World Power Conference, through its International Executive Council, has selected Vienna for the Fifth World Conference to be held June 16-25, 1956. This will be a full meeting. The Conference is composed of organizations in the power field throughout the free world.

At a recent section meeting in Rio de Janeiro, Paraguay and Thailand were

Streamlining **SAVES PRECIOUS FUEL**

STREAMLINE the flow of gases across the boiler tubes and you get more steam from less fuel. That is what Enco Baffles do. They use scientifically curved baffle surfaces instead of sharp angles. They taper the passes to maintain velocity as the gases decrease in volume, which promotes heat-transfer. They:

- **Eliminate bottle-necks**
- **Abolish dead gas pockets**
- **Reduce draft losses**
- **Speed heat transfer**
- **Keep heating surfaces cleaner**
- **Cut down use of soot blower**
- **Provide for tube expansion and replacement**

Adaptable to any type of water-tube boiler, fired with any fuel. Designed for each individual installation. Only selected materials used. Installed by skilled mechanics. Send for Bulletin BW 44.

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Produced exclusively by The Engineer Co

It's Quality Deserves Consideration

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TOP and LOWER SIDE CONNECTIONS

UPPER SIDE AND BOTTOM CONNECTIONS

Factory calibrating or zeroing adjustment produces a correct 3 to 15 pound signal output for full float range operation, as particularly required in liquid level indication. Output signal of controller is linear as related to level height change.

Simple level adjustment indicating dial.

Pneumatic proportional band and specific gravity adjustment combined in one member.

Small compact relay unit, minimum working parts.

★ All welds are in accordance with ASME code for unfired pressure vessels.

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- LIQUID LEVEL CONTROL
- LIQUID LEVEL INDICATION
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Engineered for peak performance the Fisher Series 2500 Level-Trol is designed to give rugged, trouble-free service. It is high in sensitivity and accuracy . . . it is versatile in handling all kinds of liquids, with minimum service attention.

Fisher Bulletin F-3 gives full details . . . write for your copy today!

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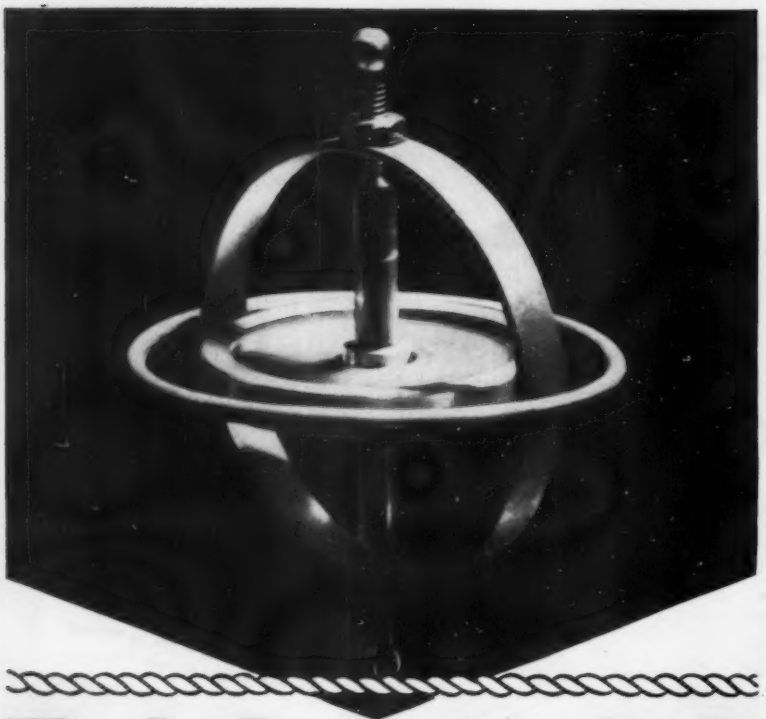

BALANCE

For *true worth* the cost of industrial insulating materials and installation should be balanced against the efficiency and life of the insulation.

First cost may be a deceptive indicator of insulation value. You may spend double the amount necessary and not get your required protection. On the other hand, the lowest bid can be the costliest.

Mundet has a closely integrated, experienced, nation-wide organization. Our engineers will survey your plant to see that the necessary lines and equipment are insulated with the *right material* and the *right thickness* to provide greatest economy and longest life.

The value of Mundet service can be easily demonstrated. The quality of Mundet insulating products is guaranteed. Mundet Products cover every temperature requirement from minus 200°F. to plus 1900°F. One of our newest products is WATER RESISTANT 85% magnesia designed to protect hot piping and equipment from water exposure damage. Send coupon for information on this and other Mundet products.

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More POWER NEWS

Begins on page 160

admitted to membership and Spain was readmitted. A total of 526 persons, from 33 countries, attended the Brazil sessions. There were 94 technical papers presented. Other meetings scheduled were announced as follows:

International executive committee, Paris, May 31, 1955; sectional meeting, Jugoslavia, 1957; sectional meeting, Canada, 1958; sectional meeting, Switzerland, 1960; Sixth World Power Conference, 1962, country to be designated.

Plant safety rules presented in new book

► The National Safety Council's new illustrated book, "Safety Devices and Ideas" describes more than 90 shop-made devices that have proved effective in plant use. Although designed primarily for chemical plants, the ideas have application in other industries.

Price is $1.25 to Council members, $2.50 to others. Write National Safety Council, 425 N Michigan Ave, Chicago 11, Ill.

Coming Events

Oct 11-15—American Institute of Electrical Engineers, fall general meeting. Morrison Hotel, Chicago, Ill. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Oct 13-16—National Industrial Conference Board, annual conference on atomic energy in industry. Hotel Commodore, New York. Details from NICB, 247 Park Ave, New York 17, N. Y.

Oct 14-15—Illinois Institute of Technology, tenth national conference on industrial hydraulics. Sheraton Hotel, Chicago, Ill. Details from IIT, 35 W 33rd St, Chicago 16, Ill.

Oct 18-20—Engineers Society of Western Pennsylvania, fifteenth water conference. Hotel Wm Penn, Pittsburgh, Pa. Information from ESWP, Hotel Wm Penn, Pittsburgh 30, Pa.

Oct 22-23—Institute of Power Engineers, annual convention, Windsor, Ontario. Details from W G Child, IPE, 410 Bloor St East, Toronto 5, Ontario, Canada.

Nov 1-5—American Welding Society, fall meeting. Sherman Hotel, Chicago, Ill. Information from AWS, 33 W 39th St, New York 18, N. Y.

Nov 1-5—American Society for Metals, 36th national metal congress and exposition. International Amphitheatre, Chicago, Ill. Details from ASM, 7301 Euclid Ave, Cleveland 3, Ohio.

Nov 10-12—Industrial Management Society, annual time and motion study and

What's the difference?

. . . just four or five degrees. But if it is the difference between actual and specified performance of a cooling tower, it is ultra-important. You may spend thousands or hundreds of thousands of dollars for a cooling tower; unless it delivers cold water at the temperature specified for economical operation it will cost more and more thousands in power cost or product recovery.

There is only one sure way to get what you pay for—to purchase a tower that will fulfill your performance specifications under test . . . in your plant. You can only obtain such a tower from a manufacturer whose engineering and research facilities are equal to the task.

Thirty years of research devoted exclusively to water cooling and a complete test plant enable Marley's cooling tower engineering staff (largest in the world) to predetermine tower performance scientifically and to verify it by actual test. That is why Marley not only invites but *urges* every customer to test his tower by any accepted test standard. Marley knows and positively guarantees that every tower it offers today will meet or exceed performance specification.

To help you determine this "difference" in cooling tower performance, Marley publishes helpful technical information to assist in testing all types of cooling towers. You can get this valuable information through Marley engineering representatives in all major cities, or by writing to the Technical Services Department of The Marley Company.

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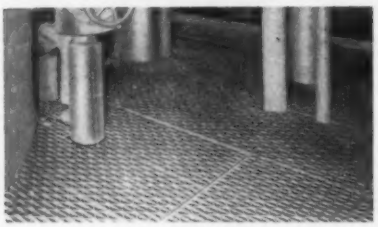
Safe Floors Start with IRVING GRATING



• non-skid surface • fireproof • versatile
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INSIDE

Flooring • Walkways • Catwalks • Balconies • Stair Treads • Fitted to specifications around Turbines, Machines, Pipes, Pillars, and other irregular shapes.

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Draingrates • Stairways • Catwalks • Fire Escapes • Platforms • Runways

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More POWER NEWS

Begins on page 160

management clinic. Sherman Hotel, Chicago, Ill. Information from IMS, 35 E Wacker Drive, Chicago 1, Ill.

Nov 29—Dec 2—First International Automation Exposition, 244th Regiment Armory, New York. Details from IAE, 845 Ridge Ave, Pittsburgh 12, Pa.

Dec 2-7—21st National Exposition of Power and Mechanical Engineering, Commercial Museum, Philadelphia, Pa. Details from International Exposition o, 480 Lexington Ave, New York 17, N. Y.

Jan 24-27—American Society of Heating and Ventilating Engineers, 61st annual meeting and 12th international heating, ventilating and air-conditioning exposition. Philadelphia, Pa. Details from ASHVE, 62 Worth St, New York 13, N. Y.

Advisory committee named for heating & ventilating show

THE ADVISORY COMMITTEE for the 12th International Heating and Ventilating Exposition will be headed by L N Hunter, president of the American Society of Heating and Ventilating Engineers. The exposition is to be held at Philadelphia's Commercial Museum and Convention Hall on Jan 24 to 28, under sponsorship of ASHVE in conjunction with its 61st annual meeting.

ASHVE members on the advisory committee include: L N Hunter, Chairman, president of the Society; J E Haines, first vice-president; E R Queer, treasurer; P B Gordon, member of Council; R S Dill, chairman of committee on research; as well as M F Blankin and H P Gant, past presidents. The following Chapter presidents will also serve on the committee: L M Church, Philadelphia; E H Taze, Baltimore; R L Stinard, New York; H M Patrick, North Jersey; E C Hach, Pittsburgh. J W McElgin, general chairman 61st annual meeting and C S Leopold will also serve.

Additional members of the committee, representing trade and engineering groups allied with the industry, remain to be announced.

Approximately 400 manufacturers have engaged exhibit space. Included are products in raw and fabricated materials, parts, single-purpose units and complete systems representing every manufacturing requirement and every class of service.

Industrial film bibliography of NMTA adds 240 new titles

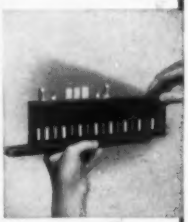
► A COMPLETE LISTING of industrial motion pictures, sound slidefilm and silent filmstrip has been compiled by National Metal Trades Assn with publication of its 1954 supplement to the

Make Accurate BOILER WATER pH, PHOSPHATE TESTS this simple way

A. Fill three test tubes with sample to be tested and place them in base.

B. Add reagent to middle tube only.

C. Place color standard on base, move across until colors match and...



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TAYLOR COMPARATORS *with* GUARANTEED COLOR STANDARDS

Taylor Comparators give you accurate pH, chlorine, phosphate or nitrate determinations . . . quickly . . . using these three simple steps. Best of all, Taylor Liquid Color Standards carry an unlimited guarantee against fading, thus, there's no chance of mechanical inaccuracy.

Taylor sets are lightweight, strong, and compact. You can carry them with you in the plant to avoid the need for carrying test samples to the lab.

Many different slides can be used on the same base. All color standards for any one determination are housed in one slide . . . no fragile single standards to handle.

FREE HANDBOOK

"Modern pH and Chlorine Control" illustrates and describes complete Taylor line as well as theory and application of pH and chlorine control. Write for your copy. Or, see your dealer for Taylor sets.

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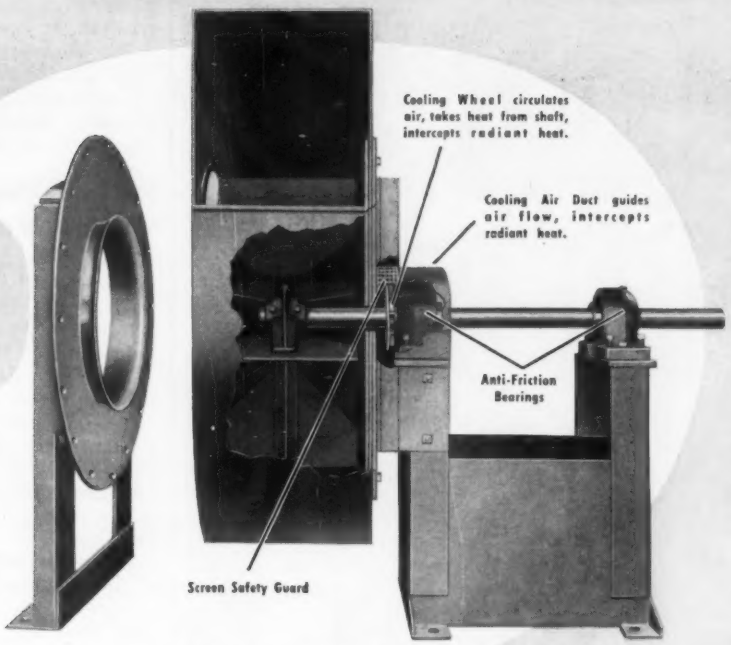
high temperature air handling?


Cooling Wheel circulates air, takes heat from shaft, intercepts radiant heat.
Cooling Air Duct guides air flow, intercepts radiant heat.
Anti-Friction Bearings
Screen Safety Guard

New Clarage Type XL Fan shown in "opened up" view is typical of the sizes which provide universal discharge.

MONEY-SAVING SOLUTION:

Clarage's new Type XL Fans equipped with AIR Cooled Bearings!

FOR TEMPERATURES UP TO 750° F., here's a simple, dependable, inexpensive feature available on standard Clarage fans. Costlier water cooled bearings NOT required. By all means, on your next "hot" job consult the Clarage sales engineer about this money-saving optional feature.

The new Clarage Type XL Fan — with its advanced design — offers many other important advantages in industrial air and material handling.

Learn about the high efficiency, rugged construction, and in-the-field adaptability of this exceptional fan equipment by requesting Bulletin 702. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

NOTE: For heavier-duty service or temperatures above 750° F., this and other types of Clarage fans can be provided with water cooled bearings.

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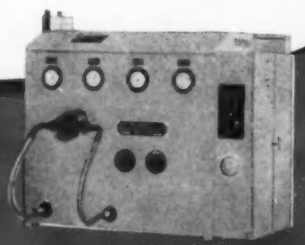
New York And Richmond Gas Company
Union Railroad Company
Universal Oil Products Company
... and many others

first choice

for dependable, efficient combustion

the PEABODY PK-54 AUTOMATIC BURNER



Since its first appearance, the Peabody PK-54 Automatic Burner has been an unqualified success. Firing oil, gas, or both—with unit capacity to 42,000 lbs. of steam per hour, this compact, *complete* burner is now the first choice for either factory-assembled boilers or conversion installations. Low noise level, complete accessibility, "built-in" forced draft fan, combustion and safety controls, are only a few features that assure peak performance. For complete details, write for Bulletin 430.

PEABODY ENGINEERING CORPORATION
[illegible] FIFTH AVENUE, NEW YORK 36, N. Y.

More POWER NEWS

Begins on page 160

Industrial Film Bibliography. The supplement, accurate to Aug 1, 1954, adds 240 new films to the standard Film Bibliography manual published in 1952. The two publications form a unique library of audio-visual aids for industrial use.

The supplement may be secured from NMTA headquarters, 122 S Michigan Ave, Chicago 3, Ill, for one dollar. Both Industrial Film Bibliography and supplement are available for two dollars.

Stone and Webster to engineer atomic power project

► THE ATOMIC ENERGY COMMISSION has announced that Stone & Webster Engineering Corp, has been selected to perform architect-engineering services associated with the design of the Pressurized Water Reactor (PWR) Project to be constructed near Shippingport, Pa.

Stone & Webster will be a subcontractor under Westinghouse Electric Corp, which has responsibility for development, design and construction of the nuclear portion of the project. Duquesne Light Co will design and construct the turbine-generator portion of the PWR plant.

Stone & Webster will design and prepare plans and specifications for the reactor foundations, containing structure, fuel handling facilities and certain other auxiliaries.

Caterpillar opens new plant at York

► OPENING A NEW PLANT at York, Pa. permits Caterpillar Tractor Co to give improved parts service to its eastern and export customers, and to expand its manufacturing facilities.

The new plant manufactures certain replacement parts for the company's line of track-type tractors, and also serves as a regional storage and shipping center for the entire parts line. Currently the total operation employs about 650 people. The entire plant includes about 770,000 sq ft under roof.

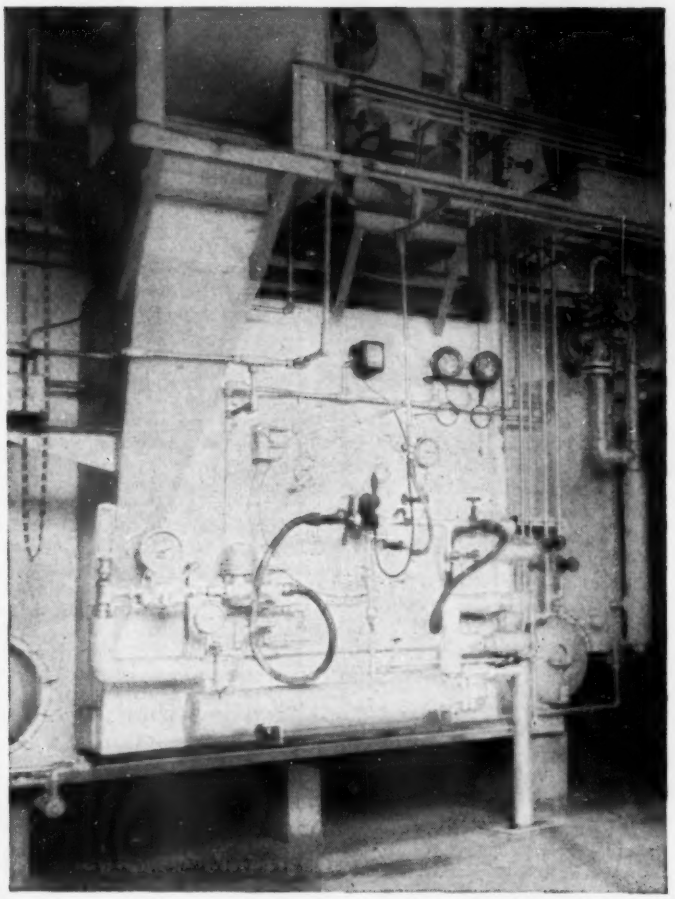
Largest capacity transformer ever constructed, a 220,000 kva, 161/19 kv unit, is physically smaller and lighter, weighing 193 tons, than lower capacity transformers built in the past. Built by Westinghouse Electric Corp, the transformer is the first of four units to be delivered to the Tennessee Valley Authority.

Allis-Chalmers Manufacturing Co has completed negotiations to furnish the Atomic Energy Commission with about $15 million worth of compressor equipment for the AEC plant now under construction at Portsmouth, Ohio.

These three fine H. J. Heinz products produced in plant equipped with WICKES BOILERS

Located in the rich truck farming area of Southern New Jersey, the Salem plant of the H. J. Heinz Company, famed makers of "57 Varieties", specializes in the production of quality Ketchup, Chili Sauce and Tomato Soup. The plant has a capacity in excess of 1,000 tons of tomatoes a day and two newly installed Wickes A-Type shop-assembled Steam Generators are helping to meet high daily production schedules. Each of these oil-fired units has 4,000 sq. ft. of heating surface and a design pressure of 250 psi. Like so many other companies that rely on steam for heat, power and processing, the H. J. Heinz Company knows that Wickes Boilers are a reliable source of low cost steam.

Wickes will design and build water-tube steam generators for any practical size and pressure. Wickes also offers a wide choice of auxiliary equipment so that you can get not only the best steam generator, but also the best correlated equipment. Consult your nearest Wickes representative or write us today.



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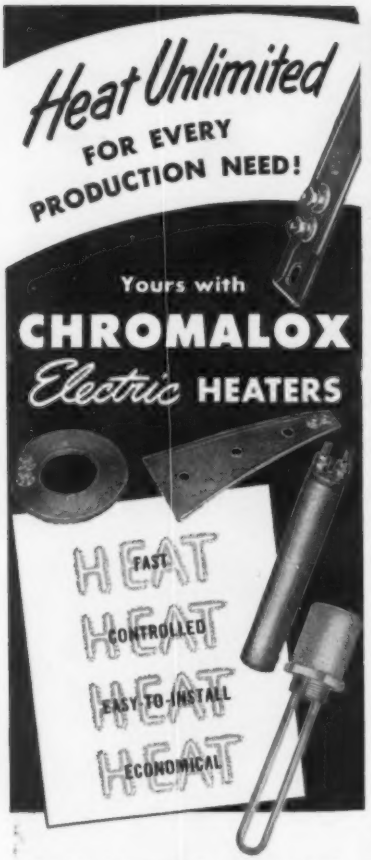

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THE BEST IN ELECTRIC HEAT

APPOINTMENTS

Corporation executive changes

U. S. Air Conditioning Corp: David E Feinberg, president. **Whitehead Metal Products Co, Inc:** Thomas M Bohen, chairman of the board and chief officer; Clayton D Grover, president. **Joy Manufacturing Co:** John Lawrence, executive vice-president. **Utah Power & Light Co:** George M Gadsby, director and chairman of the board; Edward M Naughton, president; David D Moffat Jr and Joseph E Cushman, vice-presidents.

Henry J Kaiser Co: E T Larsen and W C Rueckel, vice-presidents. **West Penn Power Co:** Streuby L Drumm, executive vice-president. **Beaver Pipe Tools, Inc:** Charles T Everett, executive vice-president succeeding W A Phillis, president, retiring.

Wagner Electric Corp: George W Brown, vice-president. **Pacific Power & Light Co:** George L Beard, assistant vice-president. **Norma-Hoffmann Bearings Corp:** Harry Walker, vice-president. **General Cable Corp:** Arthur Z Barnes, assistant to the president.

Operations executive changes

Borg-Warner Corp, Borg & Beck div: Harold Nutt, vice-president and general manager. **The Patterson-Kelley Co:** Lawrence W Bergheimer, general superintendent. **Minneapolis-Honeywell Regulator Co,** Honeywell-Brown Ltd (British subsidiary): Edward C Vorlander, managing director. **Lee Rubber & Tire Corp,** Republic Rubber div: J A MacIntire Jr, Chicago district manager.

The Texas Co: Wayne E Kuhn, general manager of newly-created research and technical dept. **General Dynamics Corp,** Electro Dynamic Motor-Generator div: Robert Hoffman, Western regional manager. **The Jeffrey Manufacturing Co,** Conveyor div: Walter J Hulsey, manager Birmingham district; Howard S Davies, manager Pittsburgh district; James B Green, manager Chicago district.

Engineer changes

General Electric Co: M N Halberg, application engineer of large motor and generator dept. **Cooper-Bessemer Corp:** W R Crooks, chief engineer of development div; T O Kuivinen, chief engineer of technical div; Dennis L Gallogly, chief engineer of product div. **The Goldak Co:** Edwin M Kaufman, chief engineer of research and production. **The Babcock & Wilcox Co:** E B Severs, development engineer in erection dept of boiler div.

Stone & Webster Engineering Corp: Edward E Bigelow, assistant engineering manager; Myrton H Cutler, chief structural engineer. **Permutit Co:** John P Termini, research engineer, special applications dept. **Struthers Wells Corp:** Fred W Emhardt, chief engineer of Warren div. **Public Service Electric & Gas Co:** Robert A Baker, power project engineer; Lee W Lemon, mechanical engineer.

Rockwell Manufacturing Co: Howard J Evans, chief engineer and manager of central gas products research and develop-

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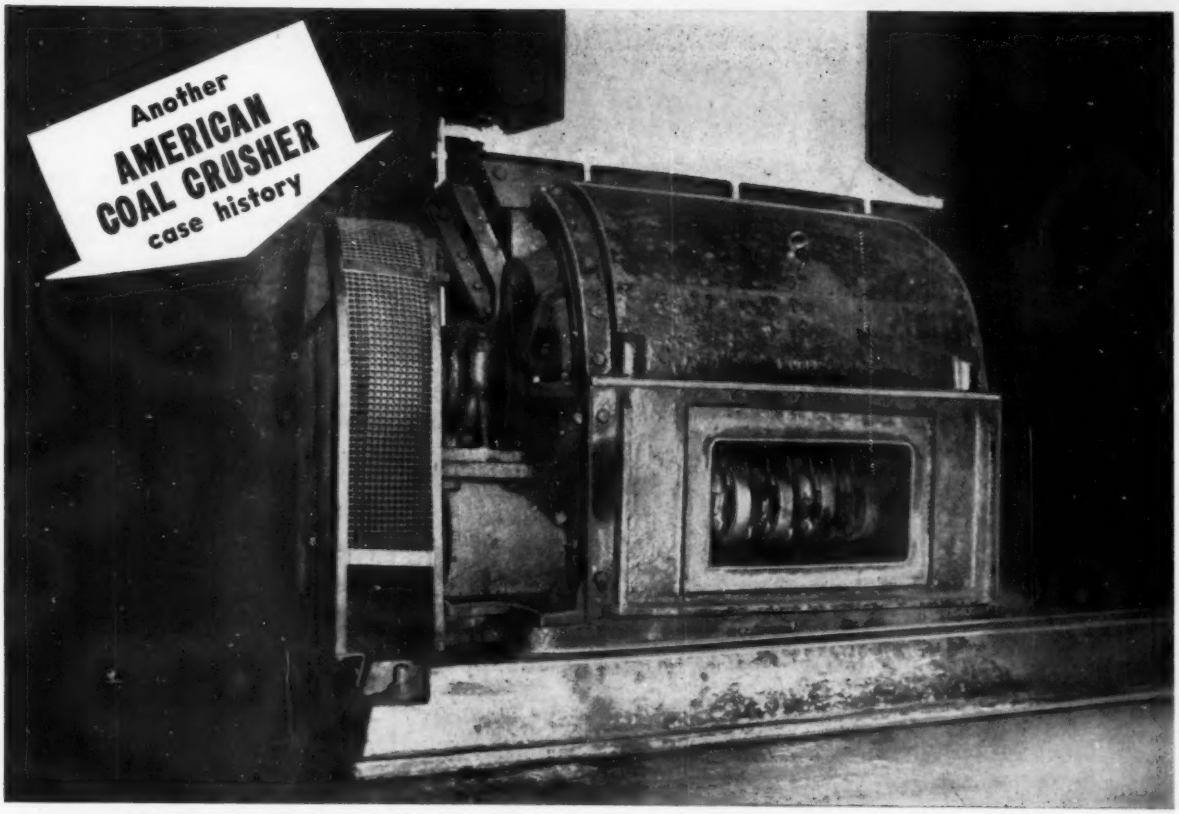

20 years . . . and 6,000,000 tons later: STILL GOING STRONG

Yes, over 2 decades ago this American Crusher 42S was installed in a New Jersey Central Station. Since then, it has continuously and faithfully crushed more than 6 million tons of coal.

But here is the eye-opening part of this enviable record: During this entire 20-year period, the total parts replacement cost per ton of coal crushed has been only $.00025. (In other words, *40 tons for a penny.*)

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Get positive, efficient control of any overhead valve right from the floor! No expensive apparatus, no switches, no costly detours to bring overhead piping to floor level — because every valve is within easy reach, when you use low-cost Babbitt Adjustable Sprocket Rim with Chain Guide. Easily assembled and installed, ready to operate in a few minutes.

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Range of 10 adjustable sizes fits all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems. Only four simple, quickly-assembled parts.

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HENSZEY FLOW METERS *with Alarm Control*

RINGS A BELL—LIGHTS A LIGHT or ACTIVATES a MOTORIZED VALVE

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SOUND ALARM AT HIGH OR LOW FLOW!

Easy to set on face of switch — unaffected by dust, dirt or corrosion — no pitting or sticking.

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More APPOINTMENTS

Begins on page 250

ment dept. H. A. Altorfer, chief engineer and manager of central valve research and development dept. **Norton Co:** Herbert A Silven, chief engineer, grinding machine div. **Henry J Kaiser Co:** Edward R Lee Jr, power engineer of Kaiser Engineers div. **Bailey Meter Co:** F D Krusemark, resident engineer in Dallas. **Colonial Broach Co:** Wilson L Young, chief service engineer. **Air Placement Equipment Co:** Wm F Rutherford, Eastern field engineer.

New sales vice-presidents

The Midvale Co: A R Gaus. **A-P Controls Corp:** Del Moerick. **Leach Corp:** R B Hutton. **Riley Stoker Corp:** Robert J Krieger. **Jeffrey Manufacturing Co:** J E M Wilson. **Fairbanks, Morse & Co:** Robert H Morse 3rd, assistant to sales vice president.

Recent purchases, mergers

General American Transportation Corp: all outstanding stock of Fuller Co and its subsidiaries, Hershey Machine & Foundry Co and Separation Process Co. **Brush Electronics Co,** div of Clevite Corp: assets of Digital Instrument Co. **Food Machinery & Chemical Corp:** assets of Chicago Pump Co. **Byron Jackson Co:** acquisition of The Rollin Co. **Shell Chemical Corp:** acquisition of Lac Chemicals Inc. **American Air Filter Co:** plant and equipment of Ice Cooling Appliance Corp. **A P Green Fire Brick Co:** assets of Liptak Furnace Arches Ltd, London.

Power Corp of Canada Ltd and **F H McGraw & Co:** incorporation of F H McGraw Co of Canada, Ltd. **American Bosch Corp.** and **Arma Corp:** incorporation of American Bosch Arma Corp.

Institute elections

Air-Conditioning and Refrigeration Institute: Marshall G Munce, elected to board of directors. **National Electrical Manufacturers Assn:** Joseph F Miller, assistant managing director; Norman Wicks, manager of business development dept, succeeding O C Small, who will become consultant.

Retirements

Samuel B Williams: assistant to board chairman of Sylvania Electric Products Inc, former editor of "Electrical World." **John P Coghlan:** vice-president of Pacific Gas & Electric Co, after more than 48 yrs. **Dunlap D Smalley:** vice-president of Southern Nevada Power Co. **Wilber A Carter:** technical power plant engineer for Detroit Edison Co, after more than 40 yrs. **Carl G Flygare,** grinding development engineer of Norton Co, after 47 yrs.

Obituaries

Frederick L Rickmeyer, 44, chief engineer of ventilation div, The Swartwout Co, July 17. **Robert C Thompson,** 42, chief engineer of control div, Electric Machinery Mfg Co, July 14. **Alvin H Baer,** 75, past president of American Society of Refrigerating Engineers, Aug 11.

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that squarely meet every WATER HANDLING REQUIREMENT

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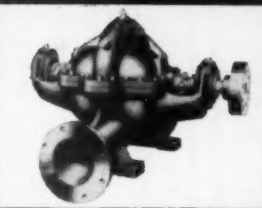

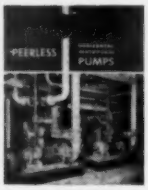

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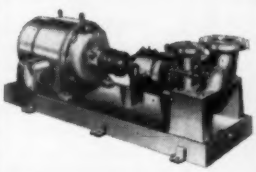

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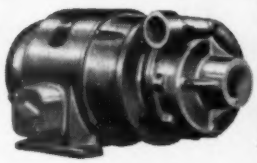
America's broadest line of economical, general purpose pumps. Horsepower range from ¼ to 150. Head range to 260 ft. Capacities up to 5500 gpm. Easy to buy, apply, install and maintain. Tens of thousands in use.



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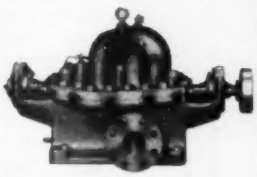
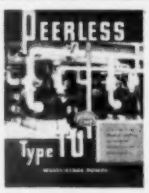
2,3,4 and 5-stage designs for supplying, circulating and boosting water and other liquids in moderate capacities against medium and high heads. Durable and dependable in operation. Heads up to 1660 feet; capacities up to 3000 gpm.





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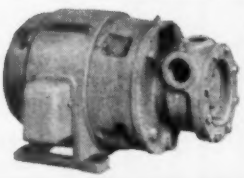
For pumping hot and cold, clear and vaporous liquids in small capacities against high heads. Widely used throughout industry for water boosting, circulating, transferring. Easy to install and maintain. Capacities: up to 58 gpm; heads up to 800 feet.



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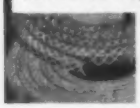

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BOOKSHELF

The Physics of Experimental Method (*1954*). *By H J J Braddick, senior lecturer at the University of Manchester, England. 404 pp, $7.00. John Wiley & Sons, 440 4th Ave, New York 16, N. Y.*

Written primarily for those who plan experiments in engineering, chemistry, etc, the book emphasizes principles of physical experiment, currently available resources and limitations of contemporary technique. Includes discussions on errors and the treatment of experimental results, mechanical design, electrical measurements, the natural limits of measurement and some techniques of nuclear physics.

Machinery's Handbook (*Fifteenth edition*). *By Erik Oberg and F D Jones. 1911 pp. 4½ x 7, flexible leather covers. Includes tables, charts and graphs. $9.00. The Industrial Press, 148 Lafayette St, New York 13, N. Y.*

Standard reference book for the mechanical industries. Includes in clear, concise form, standard as well as hard to come by data and information needed by machine designers, mechanical engineers and others in the mechanical field. Includes mechanical tables, rules, formulas, general data and is thumb-indexed for convenience in locating specific information.

Wasseraufbereitung in Dampkraftbetrieb. (*Water Conditioning in Steam Power Plant*). (*1954*). *By A Splittgerber. 7x10, cloth, 430 pp, 325 illus, 60 tables. 48 marks. Springer-Verlag, Berlin, Germany.*

Because it is published in German, this treatise will naturally have few readers among American engineers. Yet these few, mainly highly trained specialists in the field of water treatment, will find this volume of great value for reference and study. Its bibliography with 1707 entries will be particularly useful.

In its breadth and depth of treatment, this book reminds one of the typical prewar technical treatise. It is solid and detailed, both practically and technically. The range of subject matter is as broad as the power plant itself. Water treatment, scale, corrosion, etc, are discussed in relation to boilers, heaters, piping, condensers, turbines and any other steam plant equipment that may be affected.

Welding Engineering (*1954*) *By Boniface E Rossi, Executive secretary of the Pressure Vessel Research Committee, Stevens Institute. 786 pp, 6 x 9, 584 illustrations, stiff board, cloth covered binding, $8.00. McGraw Hill Book Co, 330 W 42nd St, New York, N. Y.*

A large volume covering all welding processes, metals and their weldability, design and fabrication considerations in welding, and testing and inspection. It brings together in a coordinated, readily usable form much of the published and unpublished literature on welding, including articles, reports, and correspondence.

(*Continued on page 256*)

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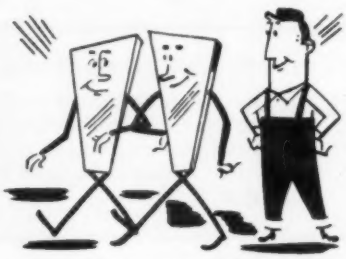

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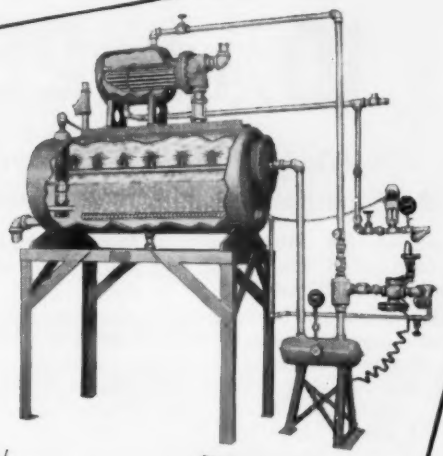

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in operating principle

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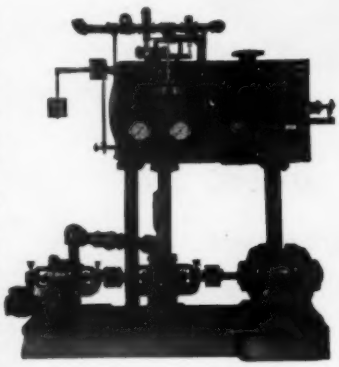

1. Reduces fuel costs 10% to 25% by completely salvaging condensate and returning it under pressure directly to boiler at 300 degrees temperature or higher—only 15 to 20 degrees less than temperature of steam at operating pressure.
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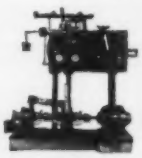


Differential Drainage and Boiler Return Systems

More BOOKSHELF

Begins on page 254

Engineering Mechanics. *Second edition. (1954). By Ferdinand L Singer, associate professor of engineering mechanics, New York University College of Engineering. 6x9¼, cloth, 525 pp, diagrams, problems. $6.00. Harper & Brothers, College Department, 49 E 33rd St, New York 16, N. Y.*

This book has been completely rewritten. Original edition had two primary purposes: to show how basic concepts—relation between a force and its components, the principle of moments, and Newton's laws of motion—can be combined and used for many practical engineering problems; and to help the student to develop a logical, orderly process of thinking. Rewritten second edition emphasizes these purposes to an even greater extent.

Already widely accepted as a text in colleges and universities, many new features have been added to the original edition. New in the second edition are: a wider variety of problems; an extensive discussion of how to draw free-body diagrams; fuller explanation and greater use of motion curves; extensive discussion of inertia-force method, and its use in simplifying systems of connected bodies; simplified presentation of space forces; work-energy method applied directly to connected systems; explanation of plane motion simplified; kinematics and kinetics of each type of motion now treated as a unit. As in the first edition, illustrative problems are solved in great detail.

Linear Transient Analysis *(Volume I). By Ernst Weber, head of department of electrical engineering and director of Microwave Research Institute at Polytechnic Institute of Brooklyn. 348 pp, $7.50. John Wiley & Sons, Inc, 440 4th Ave, New York 16, N. Y.*

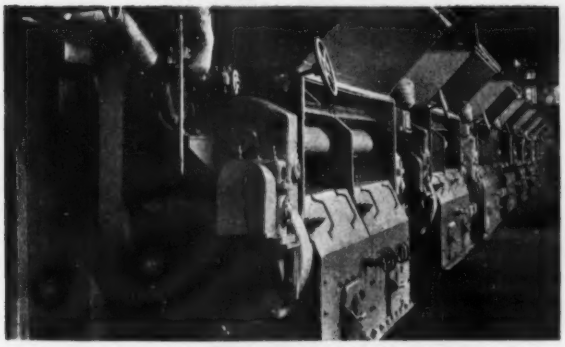
Covering all methods of transient analysis equally, the volume goes into classical and professional methods, and deals with the Laplace transform method as well as the Fourier spectrum analysis. Applications to practical circuit problems accompany fundamental expositions of each method. An entire chapter is devoted to analogues, with comprehensive discussions of electro-mechanical, mechanical and thermal systems, and their analogues.

U. S. Hoffman Machinery Corp's Syracuse Division is building two clarifier tanks for the Mesta Machine Co in Pittsburgh. These units, said to be the world's largest, are identical. They are 44 ft long, 14½ ft high, 10 ft wide, with freeboard capacities of 19,300 gal.

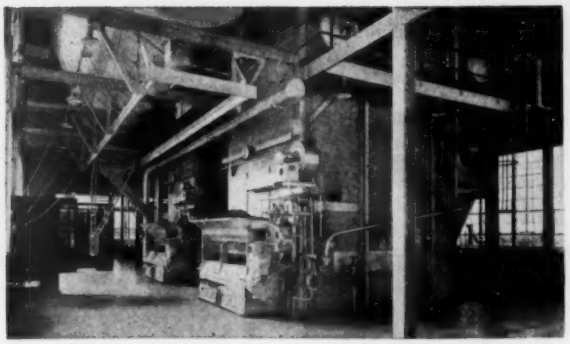
Alan Howard, manager of engineering for General Electric Co's medium steam turbine generator and gear dept at Lynn, Mass., has received the honorary degree of Doctor of Engineering from Purdue U.

The doctorate was presented in recognition of his contributions to design and development of turbines for aircraft, locomotives, power generation and natural gas pipeline pumping.

for any load

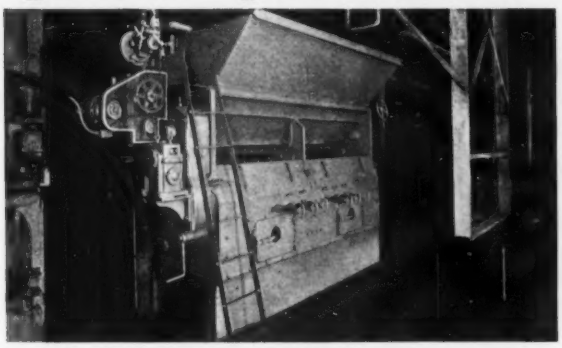


CLAIRTON WORKS—U. S. STEEL CORP.—Nine 540 H.P. Stowes—selected after careful study of all types—doubled the output of existing boilers, eliminated smoke nuisance and substantially reduced steam costs.

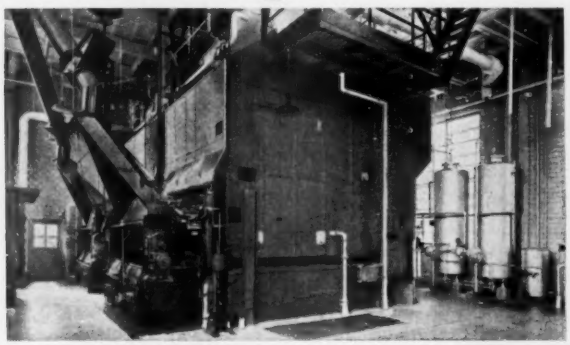


STATE HOSPITAL—Two 40,000 Lbs./Hr. Stowe Stokers burn inexpensive local coal, handle — without difficulty—loads that fluctuate in ratio of 16 to 1 combine utmost ease and simplicity of operation.

you'll get more efficiency

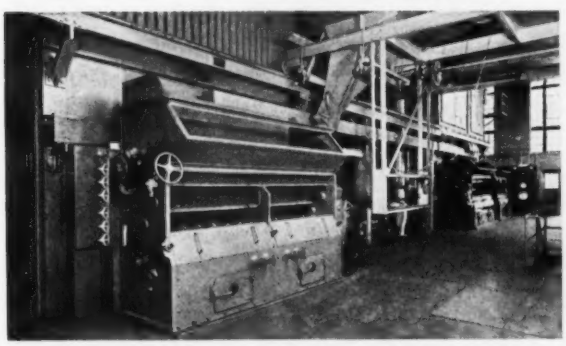


SMALL MUNICIPAL LIGHT PLANT 50,000 Lbs./Hr. Stowe replaced a multi-retort stoker—increased the boiler output—reduced maintenance costs and eliminated smoke and fly ash nuisance.

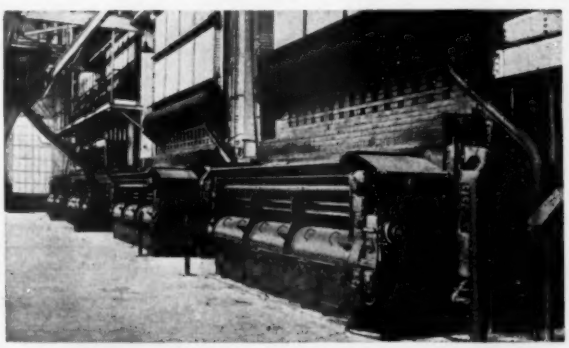


M & R DIETETIC LABORATORIES, INC.—Two 35,000 Lbs./Hr. Stowe Stokers meet exacting requirements for efficiency and smoke free operation in industry where cleanliness and low cost is paramount.

with a Stowe



UNIVERSITY OF DETROIT—Three Stowes of 300 H.P., 500 H.P. and 500 H.P. respectively, installed one after another, based on demonstrated efficiency and absence of smoke nuisance in residential area.



BODY PLANT OF LARGE AUTOMOBILE BUILDER—Stowes under four 90,000 Lbs./Hr. boilers burning inexpensive coal at high efficiency and no smoke nuisance. Concern now has 10 Stowes in its several plants.

"More Power to You" with **STOWE** *Stokers*

Manufactured by THE JOHNSTON & JENNINGS CO. • 6917 Bessemer Avenue • Cleveland 27, Ohio

.... *Division of* PETTIBONE MULLIKEN CORP...

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GET CLEAN STEAM BY DE-IONIZATION

No matter how hard or how full of dissolved solids the water may be, you can make clean steam of it if you treat it right. Sellers of steam and users of process steam will particularly appreciate the importance of such an opportunity.

REMOVE ALL DISSOLVED SOLIDS, including SILICA

By "treat" we mean that you put the raw water through cation and anion exchangers — which will completely remove all the undesirable components, and produce a water with chemical purity equivalent to that obtained by distillation. This is accomplished in closed tanks connected directly into the high-pressure supply lines.

REDUCE COST OF BOILER OPERATION

The superior water you obtain in this way is LOW COST WATER that will reduce your operating expenses in many easily recognizable ways. For details of the possibilities, write us — *we have been making practical and successful ionXchange installations ever since the necessary resins were first available.*

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NEW YORK OFFICE: 141 E. 44TH ST., NEW YORK 17, N.Y.
CANADIAN DIST: PUMPS & SOFTENERS, LTD. LONDON, ONT.

Coming in December:

a **Power** special report so exciting and unusual that every power executive will want to show it to his boss!

The title of this report is: "NEW PROFIT OPPORTUNITIES IN THE POWER SERVICES, a report to executives of American industry."

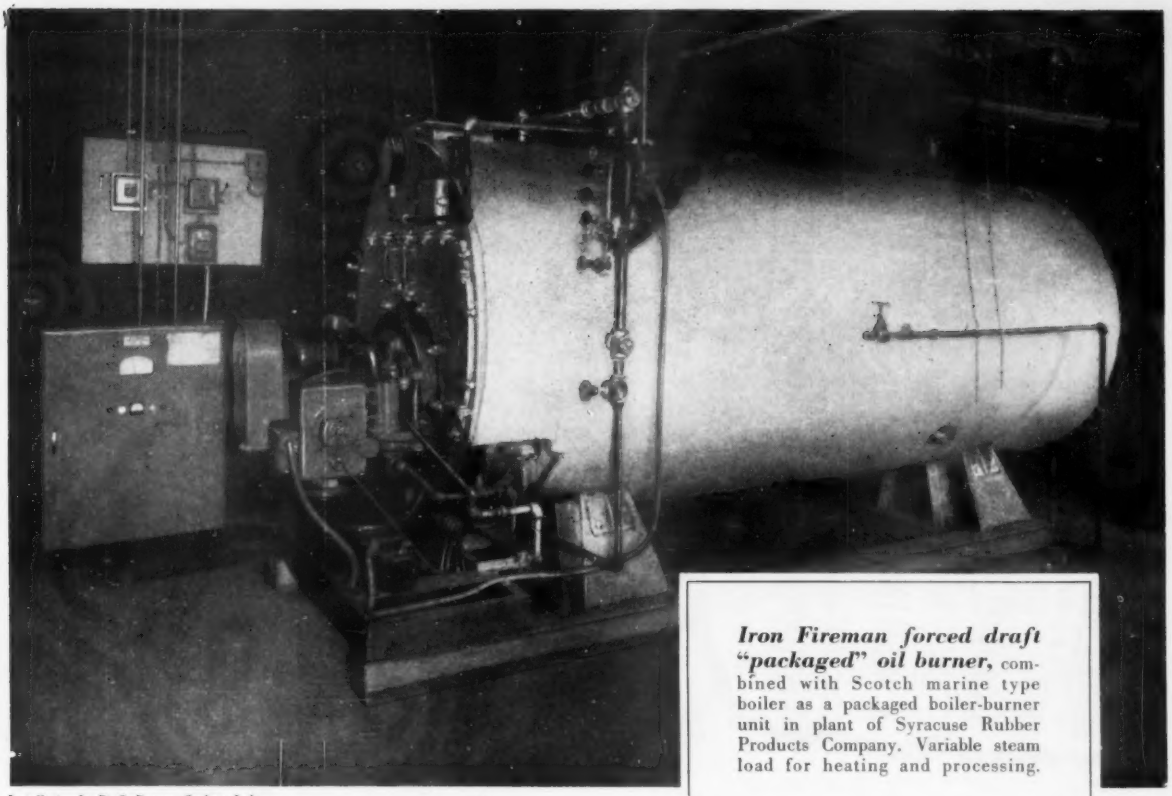
It is based on a bold statement: "Sound power service management throughout American industry . . . can save one cent in four, *adding ten percent to net.*"

Yes, POWER editors know that the cost of generating, delivering and applying the basic power services can be cut by one-fourth in the average plant. And this saving will increase net profit by ten percent!

And it is not idle talk. In 32 skillfully illustrated pages, POWER will show simply and graphically, just how these savings can be made! The fundamental services to be analyzed are: steam, electricity, mechanical power, water, compressed air, refrigeration and air conditioning. And under each subject a section called "Dollar Tips" will tell where savings are.

This could be the most carefully saved — the most sought-after — the most thumb-worn issue in POWER's more than 70 years of useful service to its field.

Coming in the December issue!



Iron Fireman forced draft "packaged" oil burner, combined with Scotch marine type boiler as a packaged boiler-burner unit in plant of Syracuse Rubber Products Company. Variable steam load for heating and processing.

Installation by R. C. Dreves, Goshen, Ind.

Boiler capacity doubled . . . no increase in fuel cost

That's the experience of Syracuse Rubber Products Co., Inc., Syracuse, Indiana, with IRON FIREMAN packaged oil burner

This new steam plant, with complete oil firing system by Iron Fireman, carries twice the load of the old one. Steam pressure has been stepped up from 90 to 125 psi. In spite of this doubled output, "the cost is about the same as the previous plant to operate," says Mr. Hubert R. Anglemyer, President. "We also have drier steam in our processing, which cannot be measured in dollars. We have had no down time. Dependability of equipment and ease of operation and maintenance are outstanding."

For further information mail coupon, or call your Iron Fireman dealer.

Iron Fireman advantages

1. Packaged burner unit (for oil, gas or oil-gas combination firing) is assembled and tested at factory instead of on the job. No divided responsibility for burner, electrical wiring, control system, oil heating equipment.

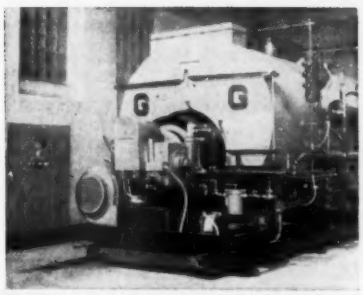
2. Applicable to nearly all types of boilers.

3. Continuous high combustion efficiency.

4. Forced draft. No high stack needed with Scotch or sealed firebox boilers. Requires only vent pipe.

5. For gas or oil, or both. Combination burner shifts fuels at a moment's notice.

6. Burns low cost oils (No. 6 or lighter).



Old steam plant out—new one in—steam up—all within 36 hours. Scotch marine boiler with Iron Fireman packaged oil burner being rolled into the plant of the Meadowsweet Dairy, Tacoma, Wash. This unit was in operation just 36 hours after the crew walked in to dismantle the old boiler—a graphic example of savings in labor and production time. Installation by Lawler Boiler & Heating Co., Tacoma

Iron Fireman®

OIL, GAS OR COAL FIRING FOR HEATING, PROCESSING, POWER

IRON FIREMAN MANUFACTURING CO.
3047 W. 106th Street, Cleveland 11, Ohio.

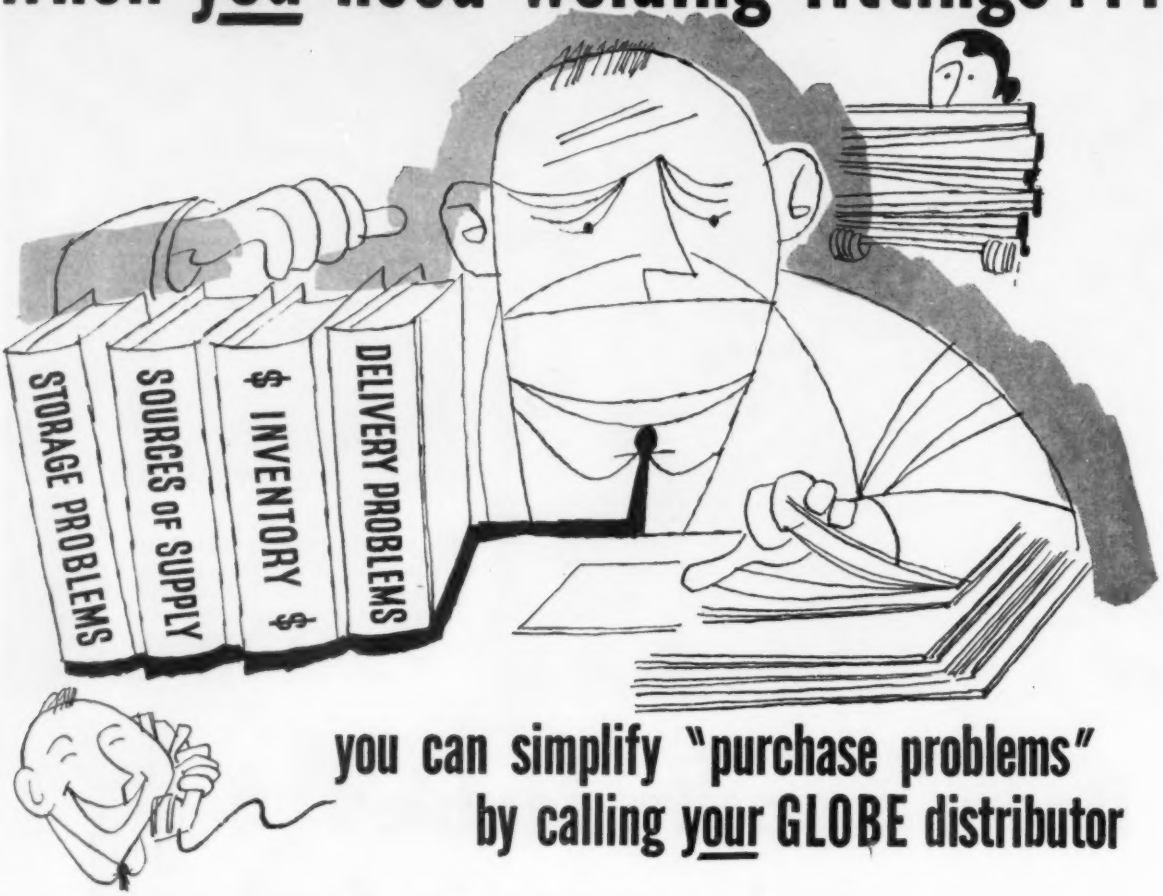
Please send detailed information on Iron Fireman packaged burner units for oil, gas, and oil-gas combination firing.

Name_____

Address_____

City_____ State_____

When you need welding fittings...



you can simplify "purchase problems" by calling your GLOBE distributor

Avoid storage problems — dollars tied up in inventory. Hold your "stock on hand" to a sensible, easy-to-work-with quantity.

Your Globe distributor carries a wide range of sizes and types of Globe Precision-Process welding fittings in stock . . . can supply you with the seamless welding fittings you need . . . *as you need them.*

Get the facts now. Contact the Globe distributor nearest you and ask him to show you how and why he'll be able to save you time, money, and trouble when you need welding fittings.

GLOBE STEEL TUBES Co., Milwaukee 46, Wis.

For the name of your Globe distributor, call any of these District Offices.

Chicago • Cleveland • Denver • Detroit • Glendale, Calif. • Houston
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Only Globe — among manufacturers of seamless Welding Fittings— produces its own seamless tubes. Only Globe offers you precision-processed fittings through every step of production — from billet to tube to fitting.

GLOBE
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SEAMLESS WELDING FITTINGS

GLOBE TUBES

Producers of Globe seamless stainless steel tubes— Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high-purity ingot iron) seamless tubes — Globe Welding Fittings.

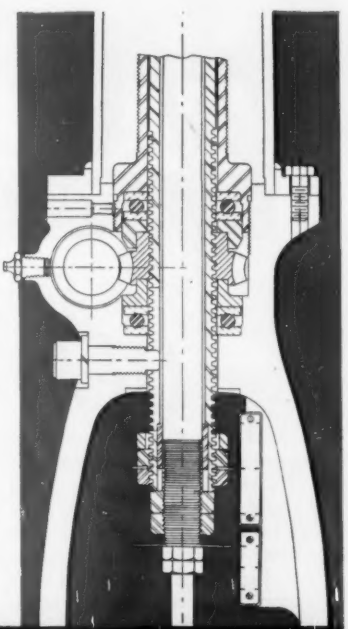
The Beauty of Functional Design

IN THE **HAMMEL-DAHL**

CONTINUOUSLY CONNECTED HANDWHEEL...

Achieved by integrating parts in the ***compact, completely enclosed*** gear housing illustrated below.

- STRAIGHT-LINE LIFT—No side thrust is exerted against the valve stem.
- COMPLETELY UNHAMPERED AUTOMATIC OPERATION—Permits limiting of valve lift if desired—but in the neutral position the handwheel mechanism offers *no resistance* to valve stem movement.
- INITIAL LUBRICATION LASTS INDEFINITELY.



COMPLETE Information in Bulletin 109-A

HAMMEL-DAHL COMPANY

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

TAPER-LOCK

A PATENTED PRODUCT OF DODGE

-OFF THE SHELF

NO REBORING!
NO KEYSEATING!
NO MACHINING!

Ready for the shaft, with no costly, time-consuming operations to make them fit. That's the big news about Dodge Taper-Lock Sprockets. Taper-Lock grips the shaft with the firmness of a shrunk-on fit, yet comes off easily. Bushings may be re-used. They come in sizes to meet most every application.

Taper-Lock Sprockets are available from Distributors' stocks in a complete range of B-type steel sprockets—½" through 2" pitch. Dodge quality Roller Chain is packaged in 10-foot lengths—also available in 50-foot and 100-foot reels. Save time—save money—keep production rolling—get Dodge Taper-Lock Sprockets and Roller Chain from your Dodge Distributor.

DODGE MANUFACTURING CORPORATION, 3200 Union St., Mishawaka, Ind.

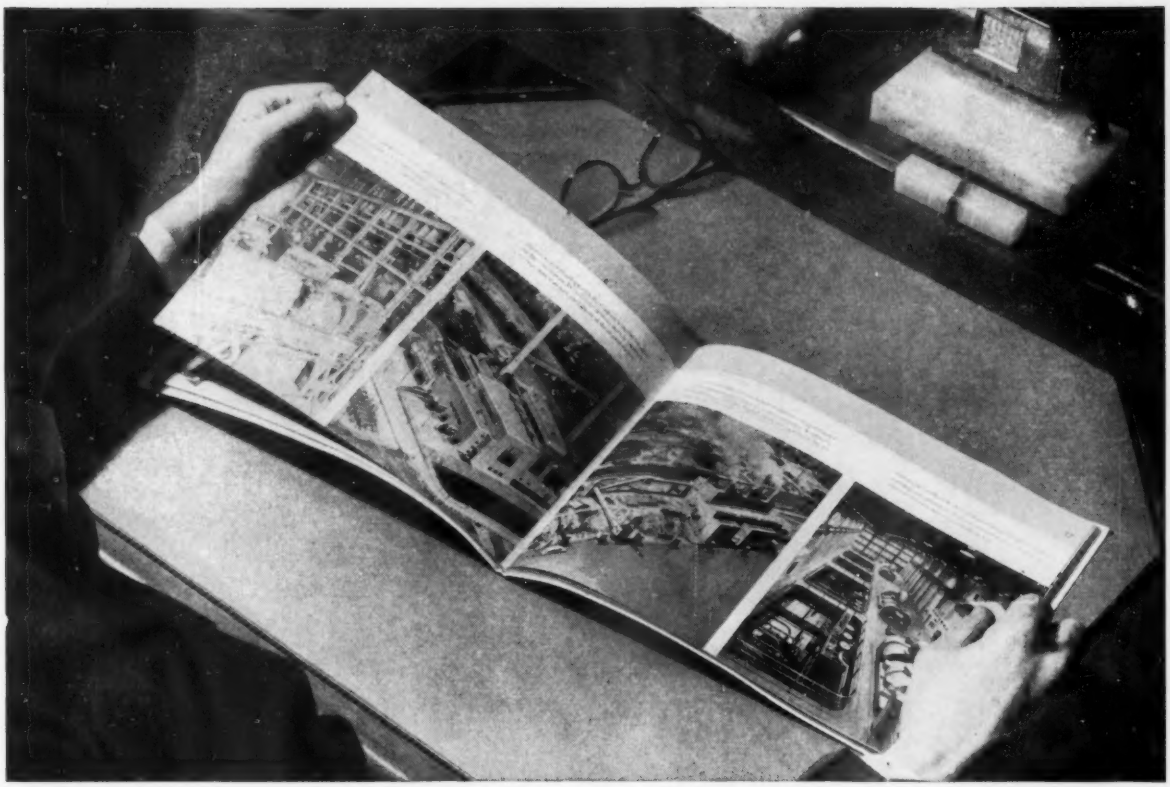
CALL THE TRANSMISSIONEER, your local Dodge Distributor, for valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

Standardize, economize with Taper-Lock, the bushing that is interchangeable in Dodge sprockets, sheaves, couplings and conveyor pulleys. *More than 2,000,000 in use!*

DODGE

of Mishawaka, Ind.



Let this BOOK show you how Dravo's Construction Department can work for you

Whether it's the installation of a pump or the furnishing and installing of a water and waste treatment plant . . . the fabrication and erection of piping . . . the construction of oil or gas pumping stations or the construction of a power plant . . . it's a job Dravo's Construction Department can do for you. Dravo's range of engineering construction activities is described in this new 45-page book, filled with photographs of many typical examples of Dravo-built installations throughout the United States.

The book also describes how Dravo accepts the responsibility for construction on a single-contract or "turn-key" basis. This includes the planning of an entire project from the blue-print stage, purchasing as designated, handling all phases of construction and turning over to you the completed job ready for operation.

Dravo's Construction Department is equipped with trained personnel—backed by more than 60 years engineering experience—and capable of performing a wide variety of construction assignments.

Find out how you can profit through Dravo's single-contract service. Let us send you a copy of "Dravo—Engineering Constructors." Ask for Bulletin No. 1200.

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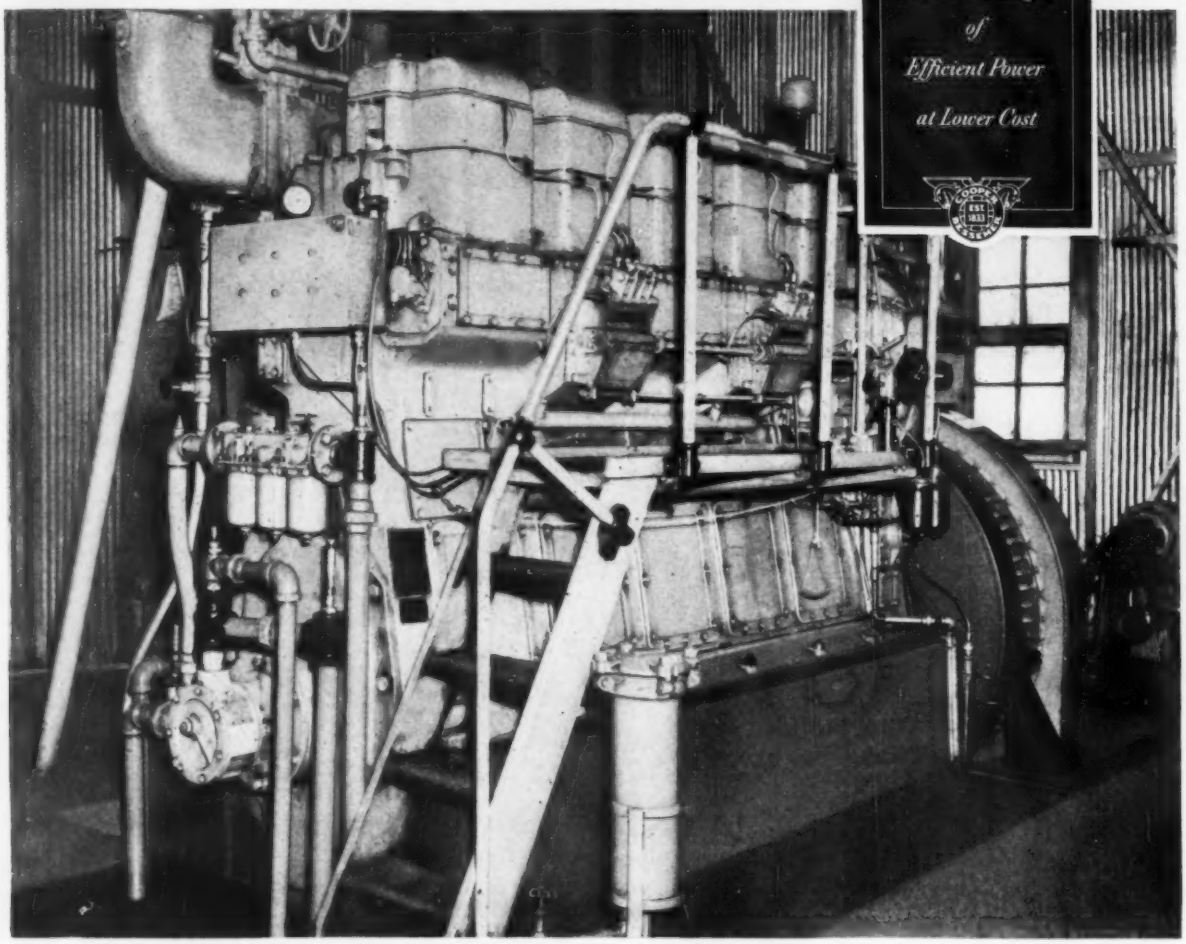
Installed at Uvalde Rock Asphalt Company's quarry, Blewett, Texas, this 430 hp Cooper-Bessemer JS-5 diesel drives a 300 kw generator for general power requirements.

Another Example of Efficient Power at Lower Cost



Steady worker, good at keeping costs DOWN!

THE Uvalde Rock Asphalt Company, which produces about 500,000 tons of limestone rock asphalt a year, needed a diesel that would stand up to steady work month in, month out. And that's just what they have in the Cooper-Bessemer JS-5 shown above. This efficient, husky diesel, installed in 1946, has done a steady job right from its initial start, with a very minimum of attention and replacement parts. Like other Cooper-Bessemer engine types, larger and smaller, the JS consistently shows records of low-cost operation. It has all the Cooper-Bessemer features that pay off every time.

The Cooper-Bessemer Corporation

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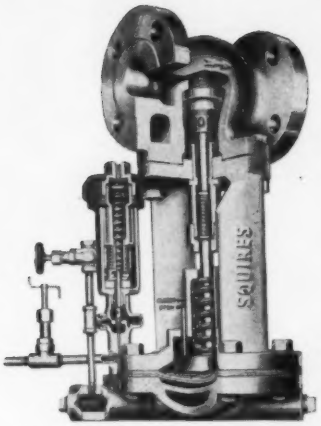
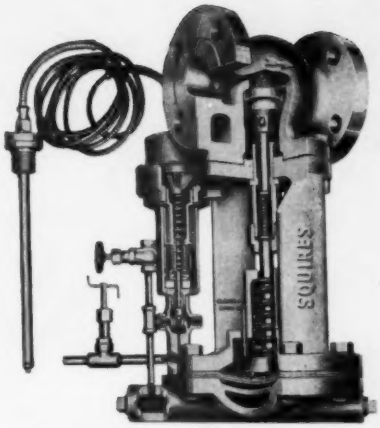
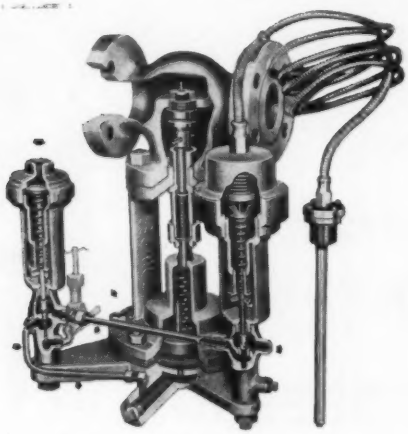
New York Washington, D. C. Bradford, Pa. San Francisco Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia Gloucester, Mass. New Orleans, La.



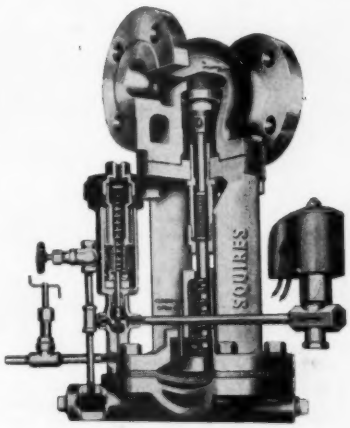
Squires Pressure Reducing Valve



Squires Temperature Regulating Valve



Squires Combination Temperature and Pressure Regulating Valve



Squires Solenoid-Controlled Pressure Reducing Valve

Here's a team of valves designed to meet your steam control requirements

These four valves form the nucleous of the Squires valve line. Each is a top-quality valve built to give trouble-free service. Check these important features:

DEAD-END SERVICE — positive — guaranteed. Full pressure dead-ends the main valve.

ONE VALVE handles pressure reduction from 600 p.s.i. to ounces.

PRECISION PRESSURE CONTROL is extremely sensitive. The patented Squires Pilot makes the difference.

SQUIRALLOY, with a Brinell hardness greater than Stellite in service, is available for seats and discs.

INSTANTANEOUS MAXIMUM CAPACITY whenever needed for process or quick high capacity demands.

If you believe in the long-range benefits of using top-quality valves—specify SQUIRES.

Other Squires products: Pump Governors—Boiler Feed Water Controllers—a complete line of High and Low Pressure Traps.

S-101

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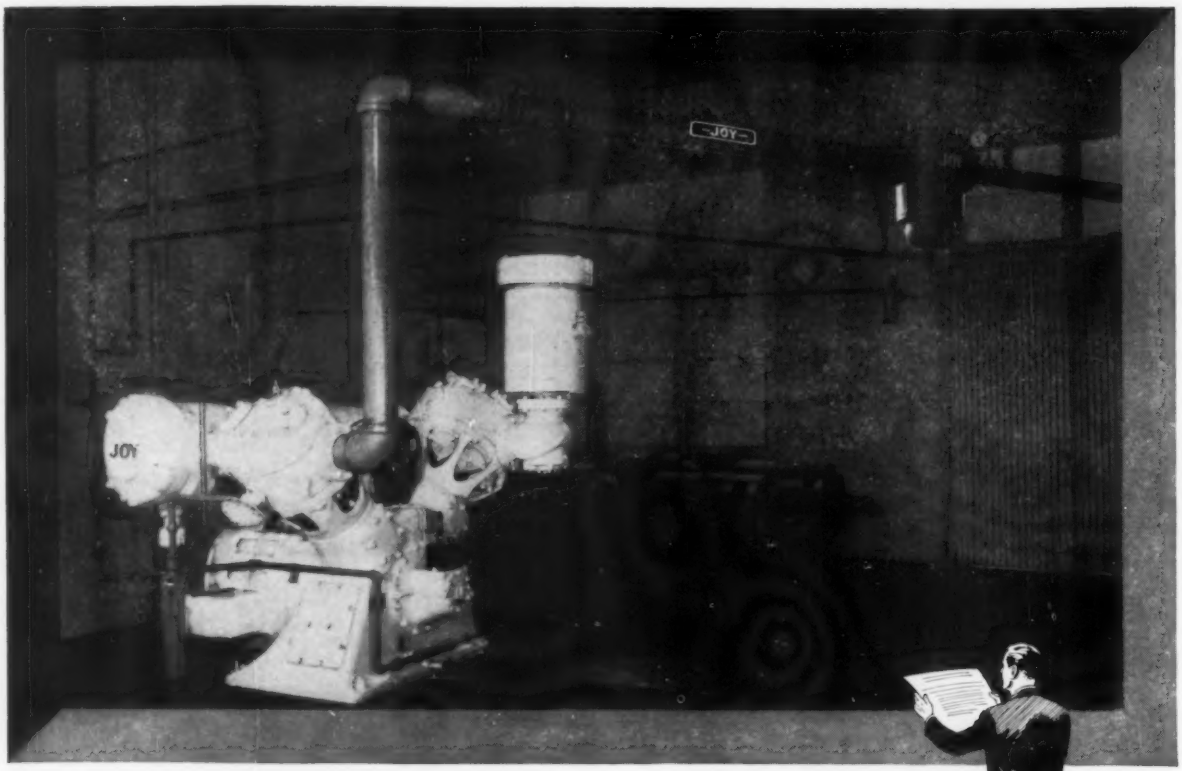

THE CONSULTING ENGINEER REPORTED:

"The Joy WN-112 is the quietest, best compressor in our experience"

This was the report of a group of consulting engineers who, working with the plant engineer, specify plant equipment for some of the country's most important air compressor installations.

That's all the engineers said, but they know Joy compressors are the "quietest and the best" because of these features:

- Honed, REPLACEABLE crosshead and cylinder liners.
- Exclusive "Dual Cushion" Valves—large area, low lift.
- Factory assembly and testing to insure permanent alignment.
- One-piece, box-type, tinned crossheads.
- Full force-feed lubrication.
- Precision crankpin and crosshead pin bearings.

The Joy WN-112 is a heavy-duty, two-stage, double-acting, package-type compressor with displacement capacities from 368 to 974 CFM. Other single-stage, two-stage, and multi-stage Joy stationary air and gas compressors are available in capacities from 2 to 3896 CFM. and pressures from 30 to 600 psi. Write today for descriptive literature • ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WBD I 5226

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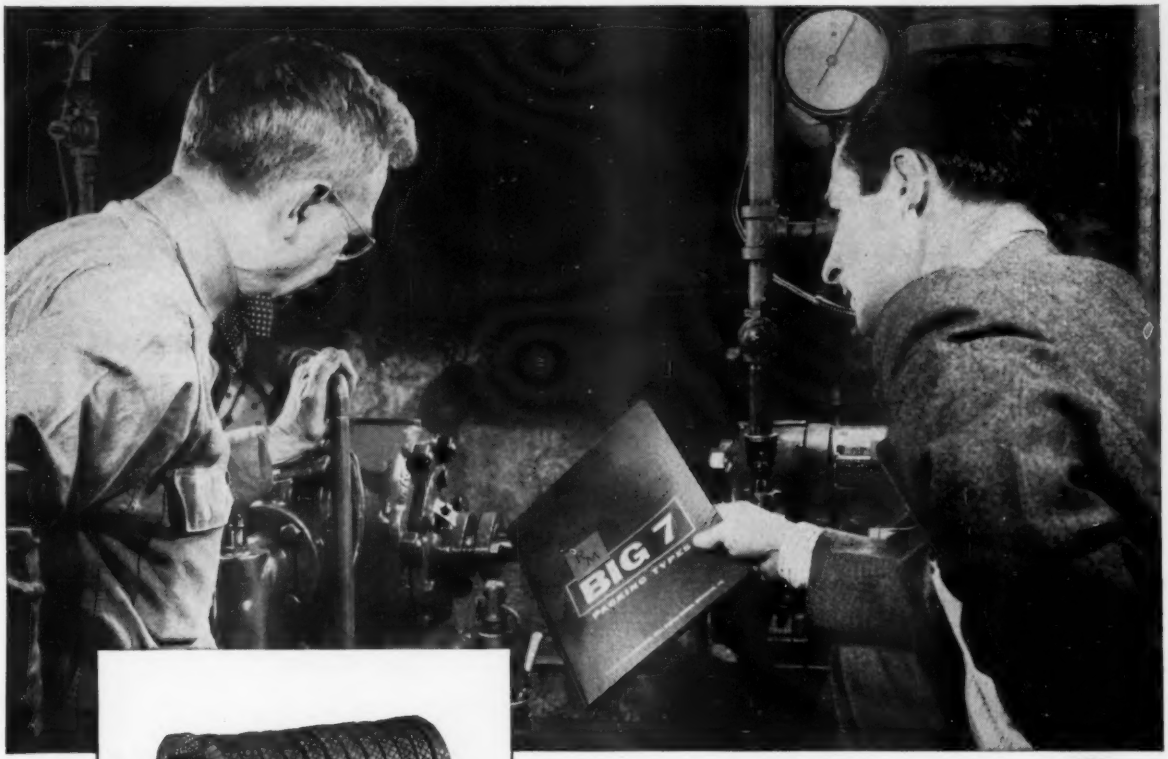
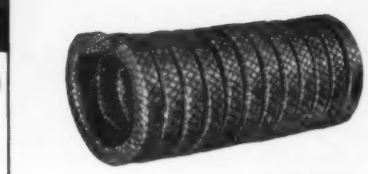
SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

R/M's BIG 7 Packing Types meet 95% of all packing needs





TYPE 3

High speed rotary compressors like this one which supplies pneumatic tools with 230 cubic feet of actual free air per minute—compressing it from atmosphere to 100 lbs. gage—give top performance with R/M Packing No. 920, a packing included in Type 3 of R/M's Big 7 Packing Types.

With R/M you can practice P/M

By R/M we mean R/M packings. And by P/M we mean preventive maintenance. Hundreds of plants have already put an end to costly corrective maintenance by standardizing on R/M's Big 7 Packing Types. You can too. For this basic line of just seven field-tested packings (you probably need only three or four) is engineered to give custom-built performance in all but the very rarest applications. You can count on them to lower your inventories, reduce your downtime, cut your maintenance costs, and simplify your ordering. For details, call in your R/M distributor.

R/M PACKINGS FOR MAINTENANCE PURPOSES ARE SOLD ONLY THROUGH AUTHORIZED R/M DISTRIBUTORS

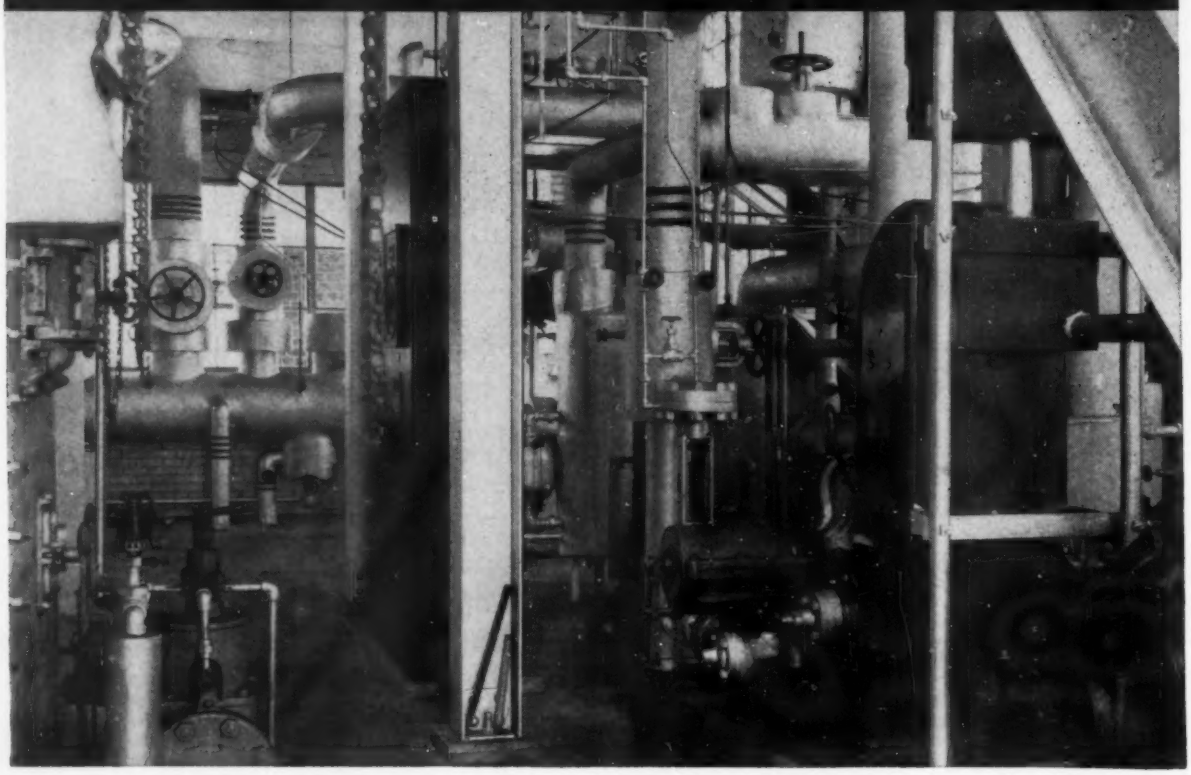
RAYBESTOS-MANHATTAN, INC., PACKING DIVISION, MANHEIM, PA.

R/M **BIG 7 PACKINGS**

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada.

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

In doubt about high temperatures and pressures?



Put your confidence in NATIONAL Seamless

● If you're planning a new power plant or repiping a present installation, you'll doubtless be dealing with higher pressures and temperatures than ever before. Your first consideration, naturally, will be the selection of the best possible material for your high pressure steam lines, since the life of your plant and the safety of your personnel may well depend on them. Consequently, you'll want the strongest, most dependable power piping you can buy—and that's SEAMLESS. Plant engineers know from long experience that there is no more dependable power piping than NATIONAL Seamless—the famous "Walls Without Welds."

You just can't beat USS NATIONAL Seamless Pipe and Tubes for power plant service—even under the most grueling service conditions. Pierced from solid billets of steel, NATIONAL Seamless Pipe and Tubes have the strength, uniformity, and dependability of solid forgings—properties that keep them structurally sound under intense pressures and ever-rising temperatures.

Write for further information on the use of NATIONAL Seamless Pipe and Tubes in safer, more dependable, more economical power installations. And for peace of mind when purchasing, always say "NATIONAL Seamless."

USS

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WALLS WITHOUT WELDS

NATIONAL *Seamless* PIPE AND TUBES

UNITED STATES STEEL

Guaranteed TO SHUT TIGHT*

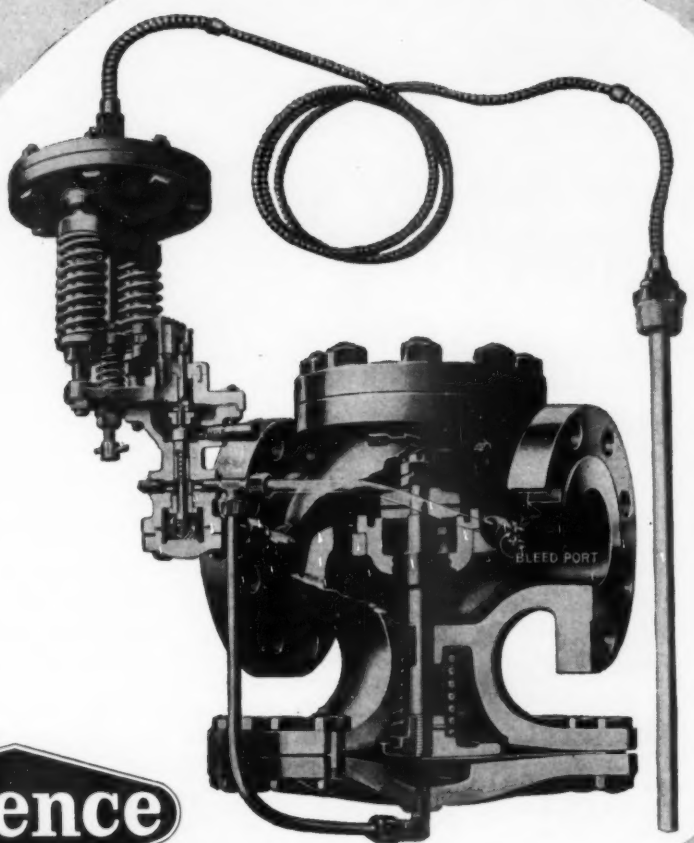
*When equipped with a SECO Metal Seat and Disc on steam service and protected by an approved Strainer, a Spence Regulator is guaranteed to shut tight when the demand for steam ceases.

Expensive steam leaks due to a lack of absolutely tight shutoff are eliminated in Spence Temperature Regulators. Here is why we can make such a guarantee:

First, our temperature regulators are of the single seat design. Seats and discs are made of durable SECO Metal. More than 20 years experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

These plus other design features explain why Spence Temperature Regulators function dependably and accurately year after year without requiring expensive repairs or special attention.

Want more facts? Write for Bulletin T50 giving full details.

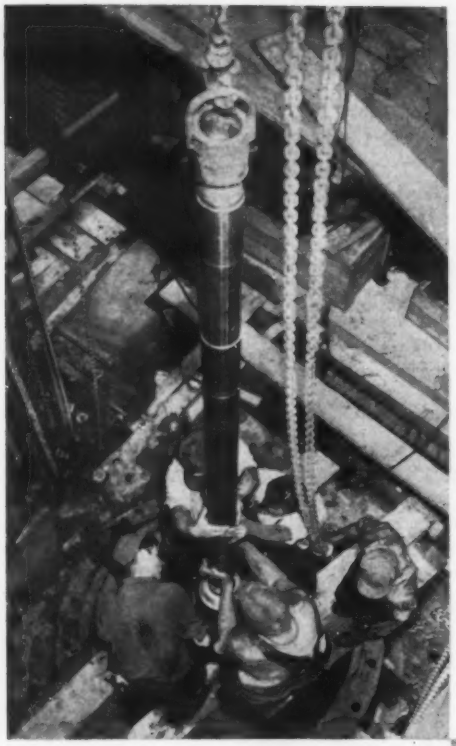


SPENCE
TYPE ET150
Temperature
Regulator

Spence

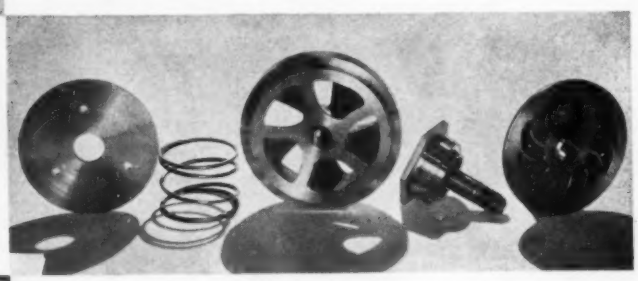
SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

SE-129



"K" Monel pump shaft being installed by utility company to avoid costly periodic breakdowns previously encountered with steel shafts in pumps circulating polluted and corrosive salt water. "K" Monel can be heat treated for great strength and hardness.

Monel pump valve for reciprocating circulating water pump withstands severe erosion-corrosion. Monel's tensile strength and resistance to fatigue are as high or higher than those of structural steel.



Ripe old age for pump parts

Cast "S" Monel liners reduce wear on pistons where gritty corrosive liquids are found. The resistance of "S" Monel to cavitation-erosion makes it ideal also for impellers in centrifugal pumps. Users have reported "S" Monel impellers lasting 3 to 30 times longer than other materials.

Some pumps are built to last; others aren't. But you can increase the service life of your pumps if you choose pump parts with the right kind of "life insurance." That means parts made of materials with exceptional resistance to corrosion, fatigue, erosion and wear; parts of high strength and hardness.

Outstanding among these more durable materials are the Inco Nickel Alloys like Monel®, "K"® Monel and "S"® Monel. A majority of pump users have found that with these alloys, pump parts last much longer.

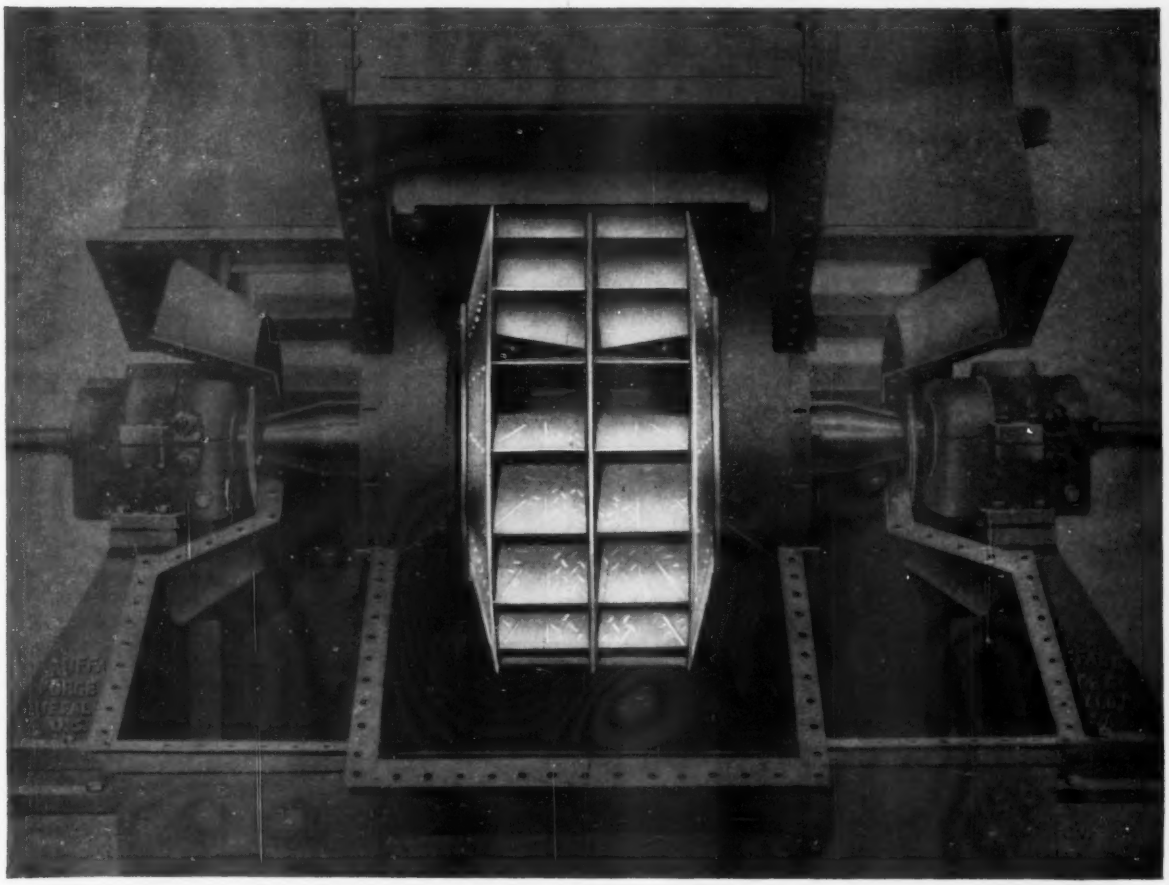
The next time *you* have to repair one of your pumps, ask your pump manufacturer to duplicate the part in one of the Inco Nickel Alloys. And write Inco for the helpful booklet, *How to Get Longer Service from your Pumps.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

More POWER for you . . . with MONEL

INCO TRADE MARK **Nickel Alloys**

How a FAN ROTOR Delivers CHEAPER POWER



. . . in "Buffalo" Induced Draft Fans

Inside the "Buffalo" Induced Draft Fan is a hurricane — a hurricane of hot, erosive fly-ash being drawn from the boiler fire-bed by a rotor like the one above. We don't have to tell you how quickly this could literally destroy an ordinary rotor — nor how expensive replacement would be. Yet the "Buffalo" rotor is built to "take-it" for a long period. Heavy gauge steel used throughout; backward curved blades for extra stiffness and efficiency — tapered side flanges cut from a solid plate—floor plate wearing strips with angular ridges to reduce erosion — heavy hub solidly bolted to the center plate. And all other parts of the fan — housing, shaft and bearings — are built to "go the distance" for you, which naturally means cheaper power. It's all part of the "Q" Factor* that's in every "Buffalo" Fan. You'll see full details in Buleltin 3750. Write for your free copy today!

** The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

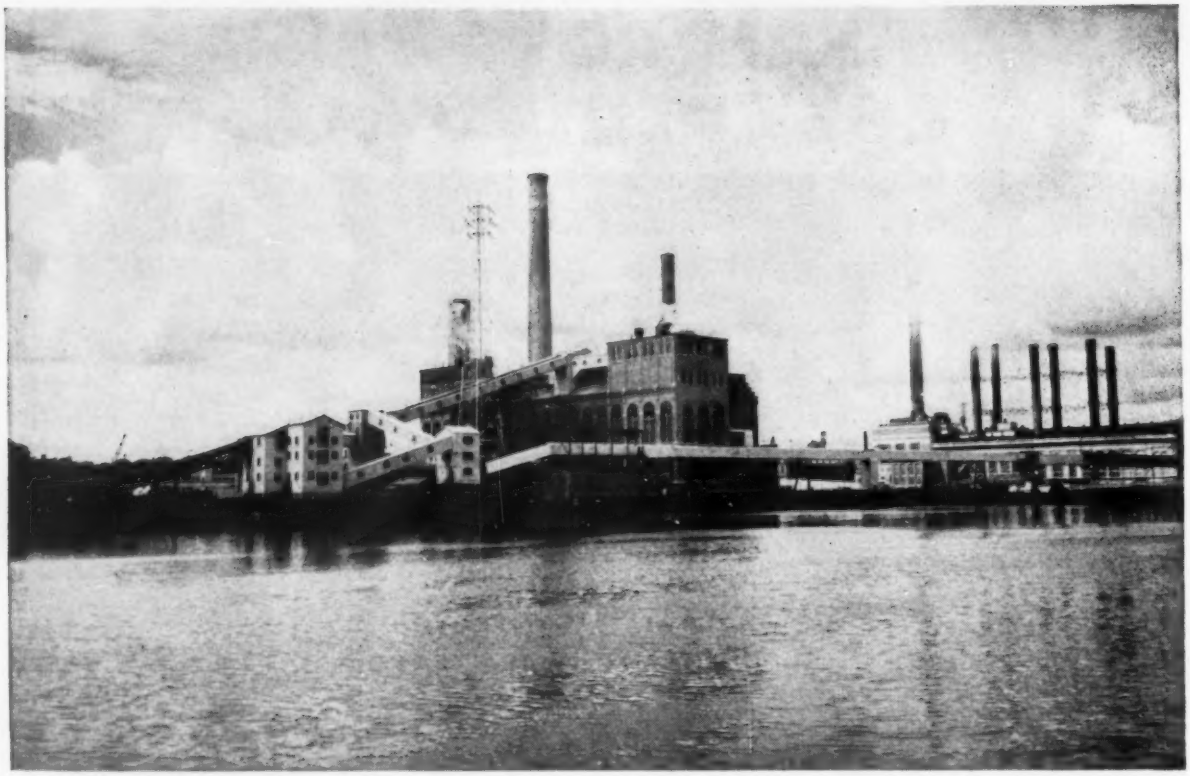
BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, N. Y.

Publishers of "Fan Engineering" Handbook

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



When coal is carried to Narragansett, U. S. Rubber conveyor belts take over

This "U.S." belt carries coal at a rate of 1000 tons per hour at a speed of 615 feet per minute, to a crushing station.

When coal arrives at the docks of the Narragansett Electric Company, conveyor belts get to work and haul the coal to crushers, then to storage, and finally to the boilers which motivate the generators. Eight different belts are used, all made by United States Rubber Company. They do their job so steadily, economically and dependably that officials of the electric company have ordered additional "U.S." belting for further expansion.

"U. S." belting technicians are constantly coming up with new developments that pay off at a dollars-and-cents level for you. Familiarize yourself with the advantages of "U. S." Three-Way Engineering. Get in touch with any of the 26 "U. S." District Sales Offices, each staffed with engineers. "U. S." belting service is also obtainable from any of our selected distributors. Or write to address below.

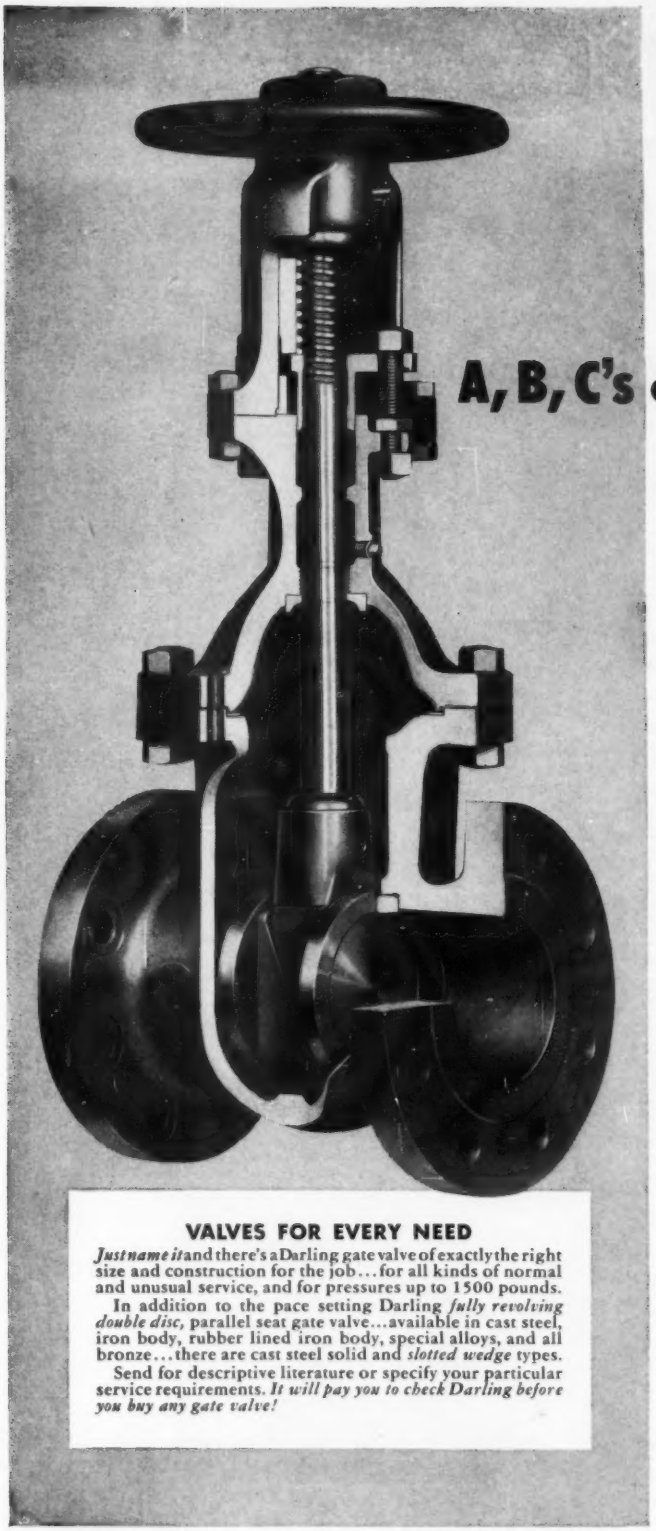
"U.S." Research perfects it.
"U.S." Production builds it.
U.S. Industry depends on it.

US RUBBER

UNITED STATES RUBBER COMPANY

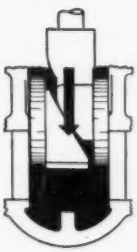
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting



DARLING VALVES

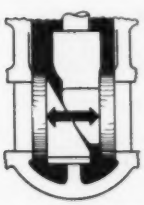
A, B, C's of better valve service with DARLING Revolving Disc GATE VALVES



GATE DESCENDING

A EXTRA LIFE

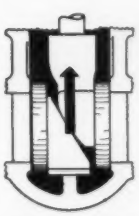
Fully revolving discs, independently hung, change seating position at each closing, assuring uniform wear distribution for prolonged service. Plain "no pocket" discs are interchangeable for *extra* life!



GATE CLOSED

B POSITIVE CLOSING

Faces of the upper wedge are radiused and faces of both wedges are transversely beveled for equalized wedging pressures and tight closing despite valve body distortion.



GATE RISING

C EASIER OPERATION

Wedging pressure on both discs is released before discs start to rise. Complete absence of wedging pressure during travel of discs assures easy operation and greatly prolonged valve life.

VALVES FOR EVERY NEED

Just name it and there's a Darling gate valve of exactly the right size and construction for the job... for all kinds of normal and unusual service, and for pressures up to 1500 pounds.

In addition to the pace setting Darling *fully revolving double disc*, parallel seat gate valve... available in cast steel, iron body, rubber lined iron body, special alloys, and all bronze... there are cast steel solid and *slotted wedge* types.

Send for descriptive literature or specify your particular service requirements. *It will pay you to check Darling before you buy any gate valve!*

DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

SIMPLE AS

Getting profitable life from castings which must face heavy abrasive service is simple as A B K.

ABK Metal castings stand up better and last longer because of carefully controlled metallic structure and specified hardness (500 to 700 Brinell). Because ABK Metal has those extra qualities that ordinary "abrasion resistant" metals lack, you can expect up to seven times greater service from ABK Metal castings.

The extra life of ABK Metal castings saves you dollars both in replacement parts and labor—cuts downtime, increases your operating efficiency. Let us show you how ABK Metal, an exclusive Brake Shoe product, can solve your abrasive wear problems.

2166

AMERICAN Brake Shoe COMPANY

CHICAGO • HOUSTON • ST. LOUIS • SAN FRANCISCO • TOLEDO

BRAKE SHOE AND CASTINGS DIVISION

230 Park Avenue, New York 17, N. Y.

JOHNSTON PUMPS serve the world

The Johnston Pump Company is instilled with the old-fashioned ideal that the successful firm justifies its existence by doing a better job today than it did yesterday. For 45 years the Johnston Pump Company has expended its entire efforts to just one end—to build better vertical turbine and propeller pumps. Energies have not been dissipated in diversified products and side lines. Johnston's new and modern factory in Pasadena is tangible evidence of the rewards of our faith in this policy, and it is a positive answer to the ever-increasing demand for Johnston Pumps by users the world over.

Plant facilities include a pump testing laboratory equipped with the latest instruments, complete shops for manufacturing precision pumping equipment, the engineering department, the general and executive offices, and the Export Division headquarters.

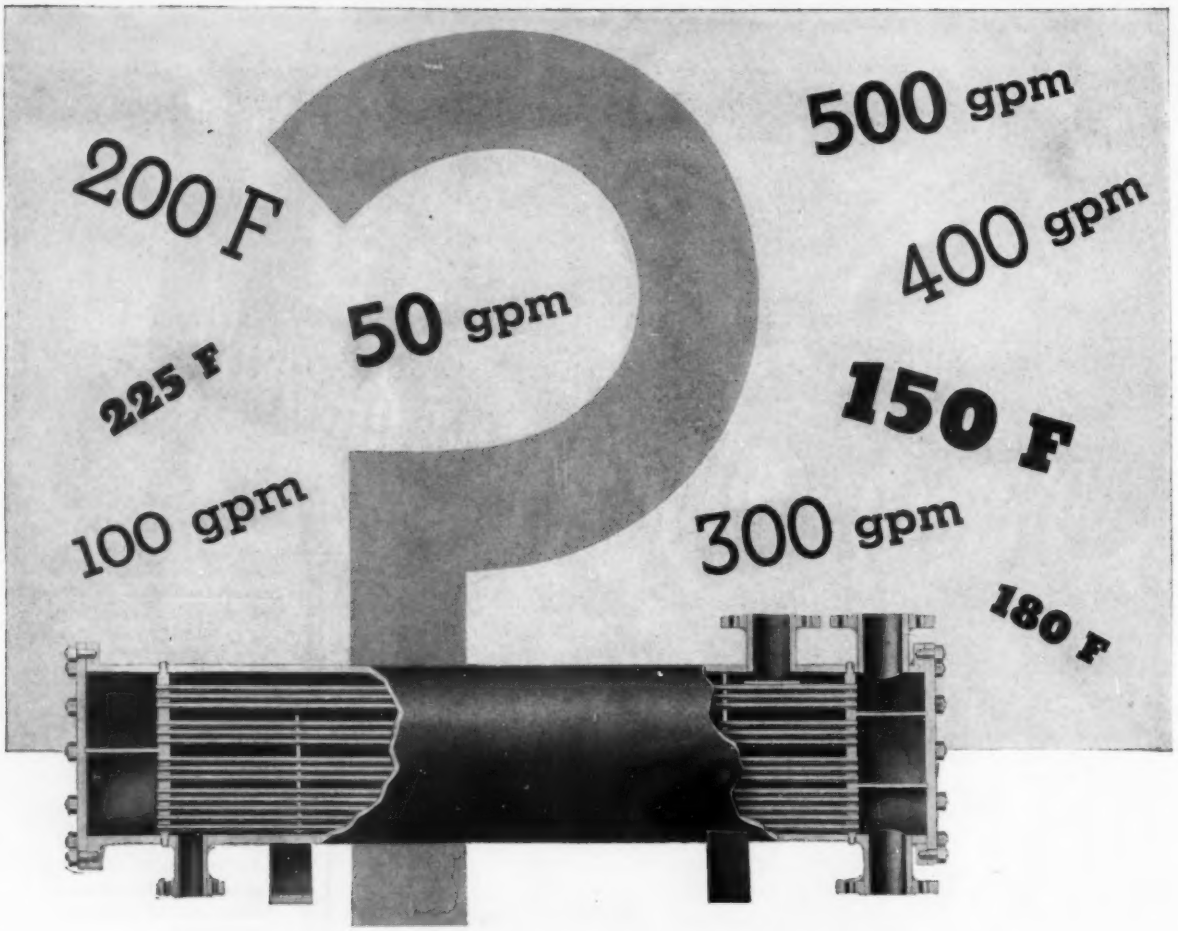
Johnston Vertical Turbine Pumps are designed for industrial, municipal and agricultural purposes. Sizes range from 4 to 32 inches; either single- or multi-stage; from 2 to 1000 H.P.; capacities from 25 to 10,000 G.P.M.; for heads to 1000 feet; for fluid temperatures to 400° F.

Johnston Propeller Pumps are designed to deliver from 500 to 100,000 G.P.M., for lifts from one to forty feet. Larger capacities and special construction are engineered and designed for unusual applications.

JOHNSTON PUMP COMPANY

3272 EAST FOOTHILL BLVD., PASADENA 8, CALIFORNIA

Headquarters for Vertical Turbine and Propeller Pumps Since 1909



How to be SURE of the fuel oil temperature and capacity you need

Correct fuel oil temperature and supply . . . essential to the proper operation of an oil-burning boiler . . . depend upon the fuel oil heater.

A G-R Type B Heater will heat your fuel oil instantly to the correct temperature and in the quantity required for your burner.

Besides its proved dependability, this unit has several important design advantages. Its arrangement of unbalanced passes permits lower cost because of fewer tubes in the final passes where the hot, less viscous oil can flow at higher velocity. Its readily removable covers provide easy access for tube cleaning, and its simplicity and sturdiness assure negligible maintenance expense.

To obtain all these benefits, be sure to investigate the G-R Type B unit when you need a fuel oil heater.

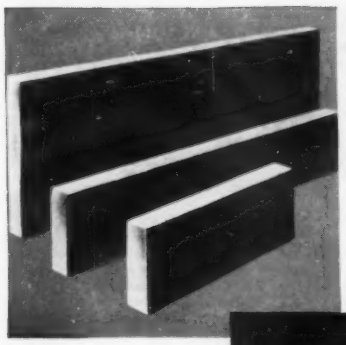
THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R HEAT TRANSFER APPARATUS **Type B Fuel Oil Heater**

GR 323

EAGLE-PICHER

Supertemp P-V Blocks



NEW STRENGTH AND LIGHT WEIGHT

for temperatures from

100 F. to 1900 F.

New light weight! Supertemp P-V Blocks are easily handled without breaking.

New strength of Supertemp P-V Blocks comes from a completely new manufacturing process developed by Eagle-Picher's research and engineering departments.

New light weight of Supertemp P-V Blocks results from the millions of "dead" air cells in Eagle-Picher's High Temperature Mineral Wool.

New strength plus extremely high thermal efficiency! Supertemp P-V Blocks are designed for continuous temperatures up to 1900 F. They're chemically and physically stable, too . . . ideal for heavy-duty insulating service.

New light weight makes P-V Blocks easy to handle—easy to apply—easy to cut for perfect fit. No special tools required.

And, of course, like all other Eagle-Picher insulation, Supertemp P-V Blocks soon pay for themselves in fuel savings and improved temperature control.

EAGLE-PICHER INSULSEAL PROTECTS! *Any insulation worth applying is worth protecting—and Insulseal provides a coating for insulation that dries to a flexible, hard, durable surface.*

Since 1843

EAGLE EP PICHER

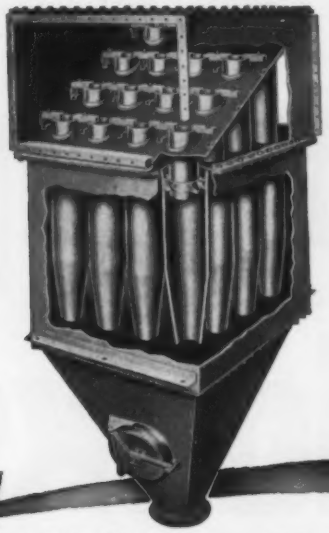
THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—
for a full range of high and low temperatures.
Technical data on request.

Member of Industrial Mineral Fiber Institute

Before you buy *any* equipment for recovering fly ash . . .



COMPARE ALL OTHERS against MULTICLONE'S Multiple Advantages

Because the advantages of MULTICLONE are so clear-cut, so vitally important, so far-reaching in the savings they make, we urge you to make a factual unbiased comparison of MULTICLONE fly ash collection equipment against *any other* in the mechanical recovery field. Only by making such a comparison can you fully appreciate the major savings and greater performance you get by installing MULTICLONE Collectors!

COMPARE Recovery Efficiency!

It is a recognized fact that the separating efficiency of a cyclonic tube increases as the tube diameter decreases because smaller tubes generate greater centrifugal forces. The patented vane in the MULTICLONE makes the use of small tubes *practical* without complicated manifolding and permits compacting many small tubes into one simple, highly efficient unit. MULTICLONE's higher centrifugal forces throw out not only the large, medium and small particles, but also an unusually high percentage of the *extremely small* particles of 10 microns and less. Result—*more complete recovery of all suspended particles from the gas stream!*

COMPARE Space-Saving Compactness!

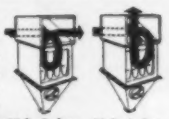
Plant space costs money—particularly at today's high construction costs. Because the MULTICLONE is more compact, size for size, it makes *really important* savings in space and plant costs. Note in the chart how the MULTICLONE requires substantially less space—*both in floor space and cubic space*—than any other unit of comparable capacity and performance. *This means vital savings in construction costs!*

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.8
Collector B	5.9	3.2
Collector C	6.8	3.9

COMPARE Dollar-Saving Adaptability!

Savings in space is just one of many ways MULTICLONE reduces installation costs. Because the shape of the unit can be readily varied (long and narrow, short and wide, or square) to fit available spaces, the MULTICLONE can often be tucked into odd corners and waste areas too restricted for other equipment.

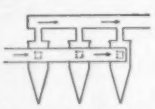
Moreover, inlet-outlet ducts can be varied—side-inlet side-outlet, or side-inlet top-outlet—to meet low headroom or restricted side clearance requirements . . . and the single-inlet single-outlet duct design permits greater flexibility and simpler installation. *These all add up to vital savings in installation costs!*



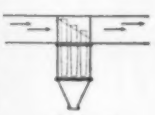
Side inlet, Side outlet *Side inlet, Top outlet*

COMPARE All-Around Simplicity!

The MULTICLONE is simple and inexpensive to maintain because there are no highspeed moving parts to repair or replace . . . no pads or filters to clean or renew . . . nothing to choke the gas flow or increase draft losses as suspended materials are recovered. In addition, the square, flat-sided shape of the MULTICLONE and its straight inlet and outlet ducts are far simpler to install and insulate. And since the recovered material from an entire bank of tubes is collected in a *single* hopper, it is much easier to service and maintain than the multiple hoppers of conventional cyclone units. *Here again, the MULTICLONE saves in many ways—all of them important!*



Conventional Cyclone



Multiclone

Whether your recovery installation is in a new structure or for modernizing present equipment, you will be far ahead by installing MULTICLONE Collectors. Our experienced engineers will gladly make helpful suggestions for simplifying your recovery problems. A letter, wire or call to our nearest office places this assistance at your service without obligation.

Send for Helpful Literature! This factual MULTICLONE literature explains the basic principles of cyclonic dust recovery and gives technical data helpful to anyone contemplating a dust or fly ash recovery installation. Write today for your free copy!

WESTERN Precipitation CORPORATION

DESIGNERS AND MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1049 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
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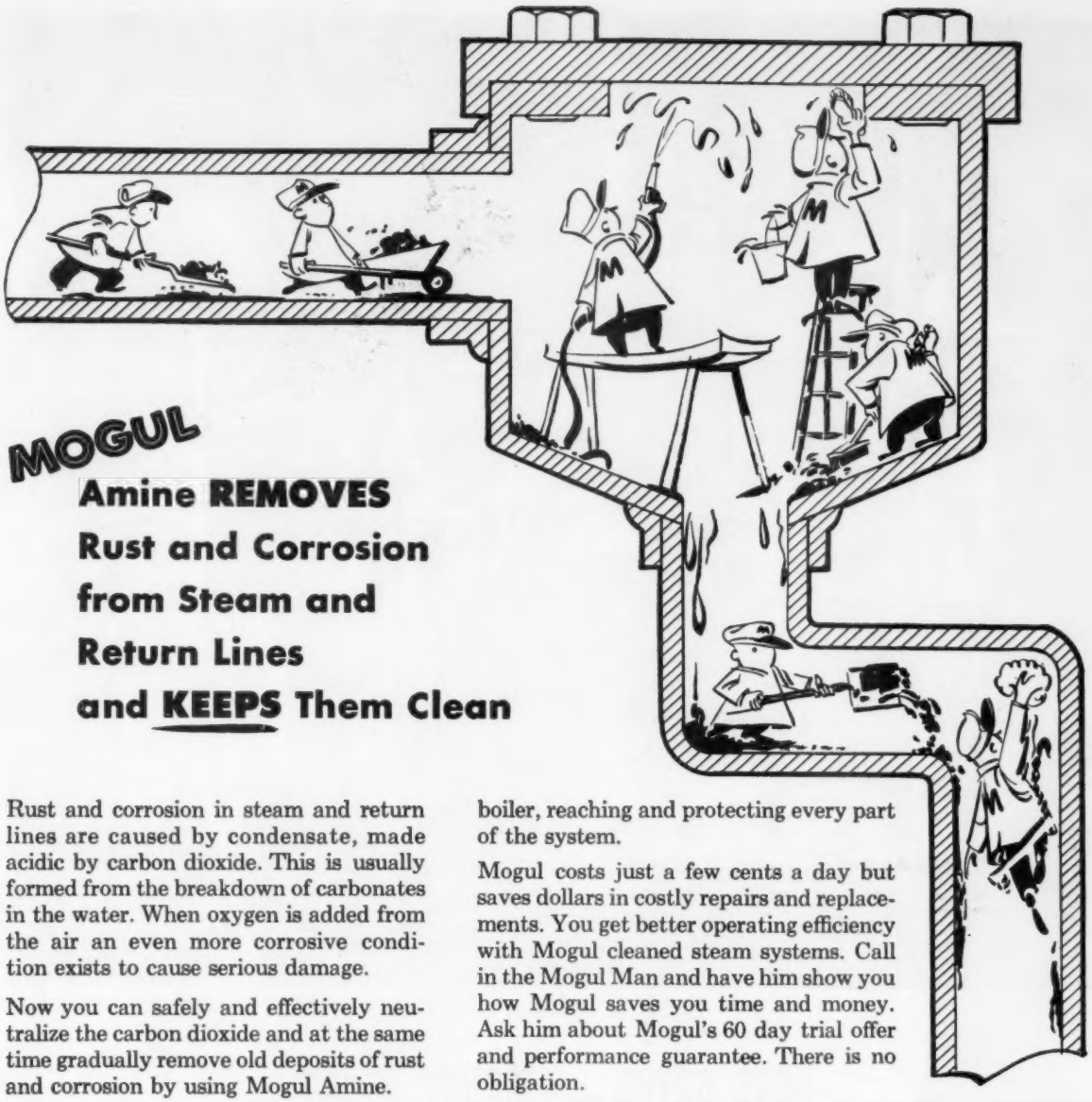
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL



MOGUL

Amine REMOVES Rust and Corrosion from Steam and Return Lines and KEEPS Them Clean

Rust and corrosion in steam and return lines are caused by condensate, made acidic by carbon dioxide. This is usually formed from the breakdown of carbonates in the water. When oxygen is added from the air an even more corrosive condition exists to cause serious damage.

Now you can safely and effectively neutralize the carbon dioxide and at the same time gradually remove old deposits of rust and corrosion by using Mogul Amine.

Mogul Amine is a carefully compounded liquid, readily mixed with water, that is injected into the boiler or directly into the steam lines. It vaporizes and travels with the steam, condensing as the steam condenses. Mogul Amine continues with the condensate through the traps, return lines, condensate tank and back to the boiler, reaching and protecting every part of the system.

Mogul costs just a few cents a day but saves dollars in costly repairs and replacements. You get better operating efficiency with Mogul cleaned steam systems. Call in the Mogul Man and have him show you how Mogul saves you time and money. Ask him about Mogul's 60 day trial offer and performance guarantee. There is no obligation.

The North American MOGUL Products Company

Cleveland 13, Ohio

The North American Mogul Products Company
Standard Building, Cleveland 13, Ohio

Send me information on Mogul Treatment for applications checked.

- ☐ Steam and Return Lines
- ☐ Hot Water and Steam Heating
- ☐ Cooling Water Systems
- ☐ Air Conditioning
- ☐ Hot and Cold Water Supply Systems
- ☐ Wet-Type Dust Collectors

Name _____

Title _____

Company _____

Address _____

_____

"Featherweight" 85% Magnesia was installed on the ducts, housings and lines of these "making" machines in the plant of Behr-Manning Corporation, a division of Norton Company. Insulation contractor—Armstrong Cork Company.

Heat saved . . . Money saved with K&M high temperature insulations

K&M insulations keep costs down by holding heat losses to an absolute minimum. You can always count on dependable "Featherweight" 85% Magnesia Insulation to provide exceptionally efficient heat conservation.

Made of 85% basic carbonate of Magnesia and asbestos fiber, "Featherweight" 85% Magnesia effectively insulates piping and equipment with temperatures up to 600°F. Used with K&M Hy-Temp insulation, its range is extended to 1900°F. This insulation combination lasts the life of the equipment it serves, withstands moisture, vibration and frequent temperature change.

New and now available is "Featherweight" Water-Resistant Magnesia insulation for temperatures up to 450°F. It is used underground where severe water exposure may damage the insulation or on indoor steam heated lines and equipment where high humidity and moisture are present.

Your K&M distributor is an experienced applicator who will gladly give you details about these money-saving insulations. Or write directly to us.

KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

Nature made asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

IN CANADA: ATLAS ASBESTOS COMPANY, LTD., MONTREAL, TORONTO, WINNIPEG, VANCOUVER

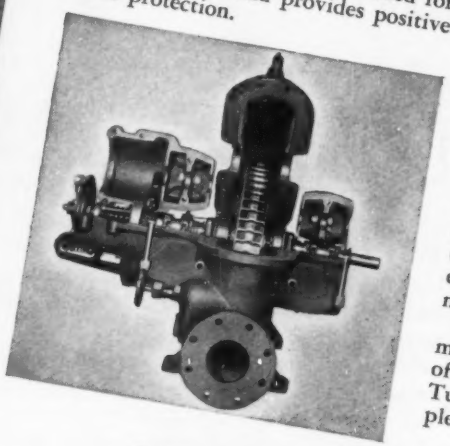
K&M Best in asbestos ®

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

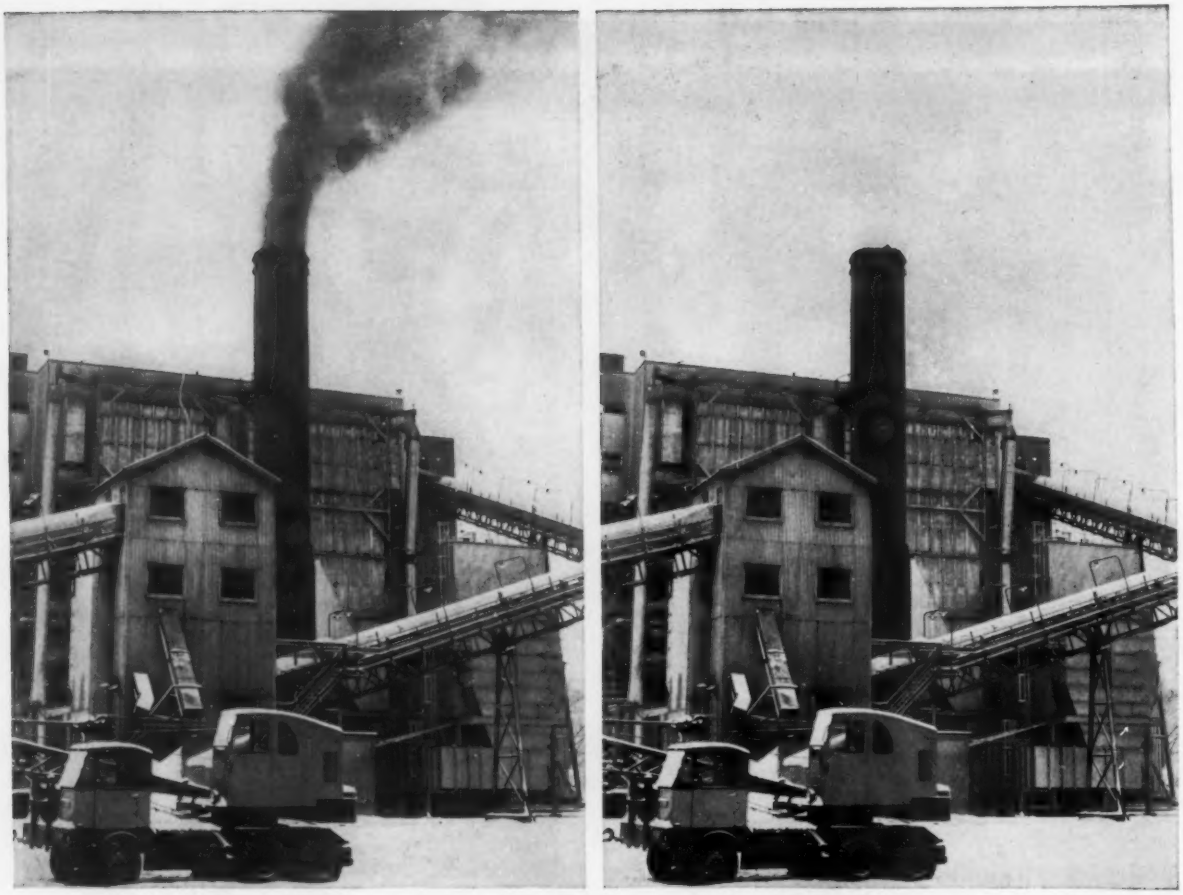
This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1195

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.



Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can *see* dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research Corporation. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research Corporation, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11% has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that far-sighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research Corporation's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

RESEARCH CORPORATION

405 Lexington Avenue, New York 17, N. Y.
Bound Brook, N. J. • Grant Building, Pittsburgh 19, Pa.
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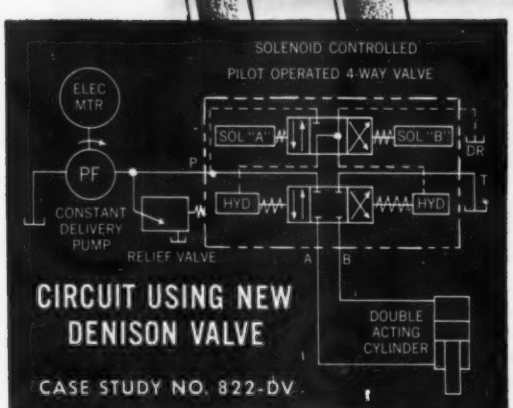

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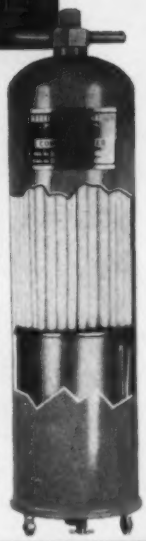

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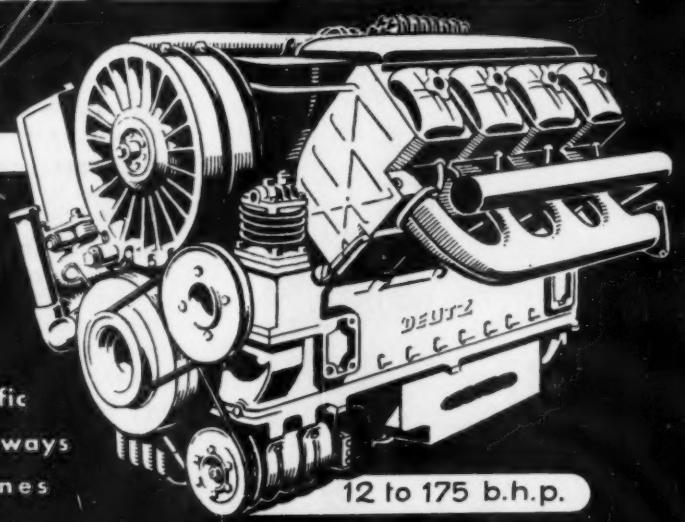

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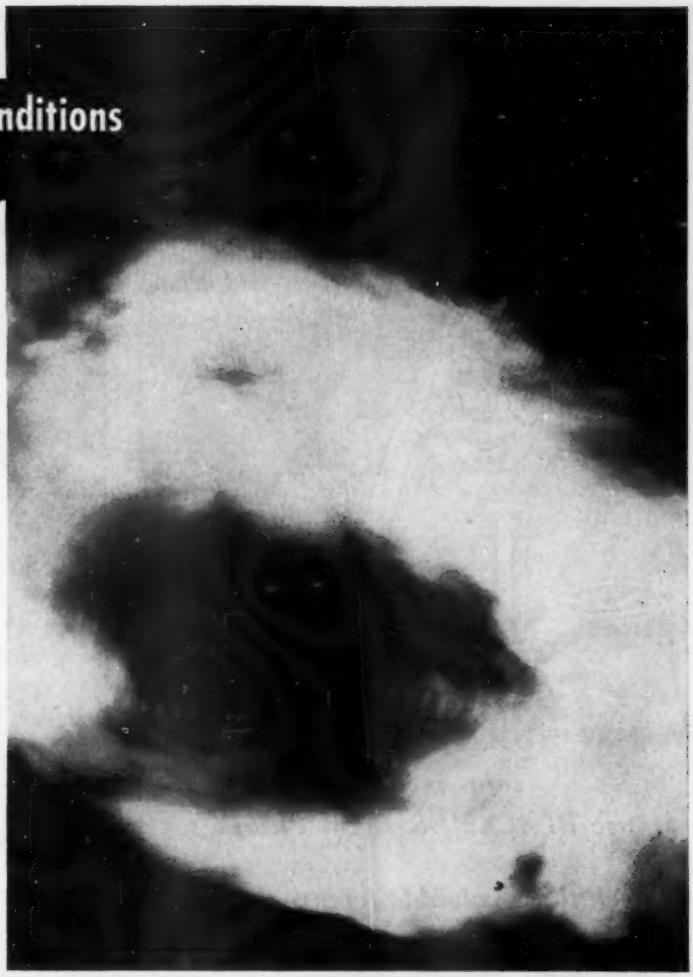

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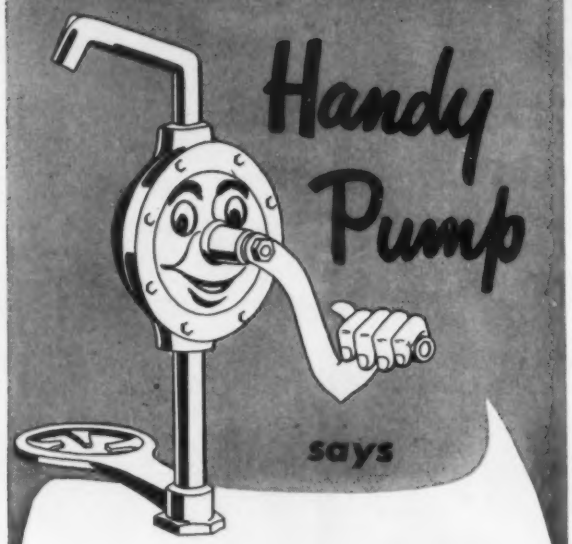

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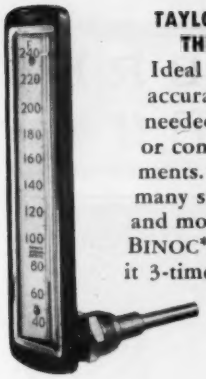

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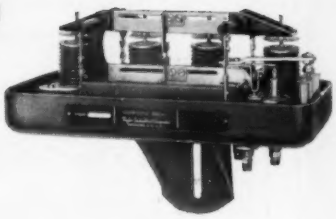

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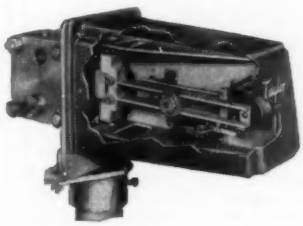

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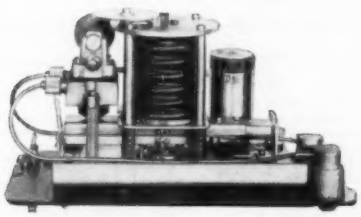

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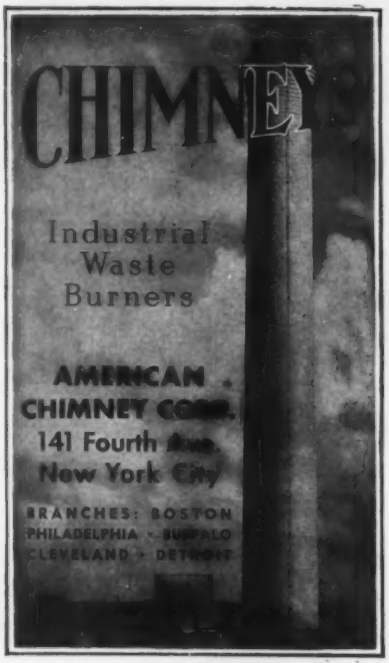

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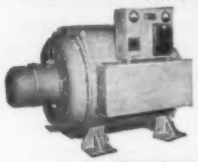

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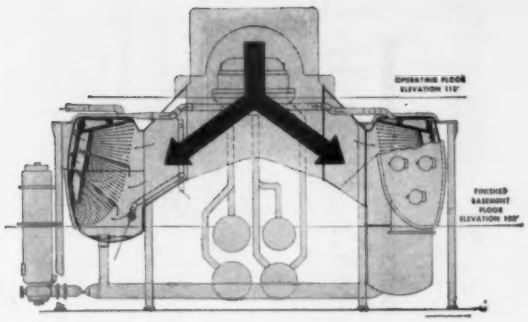
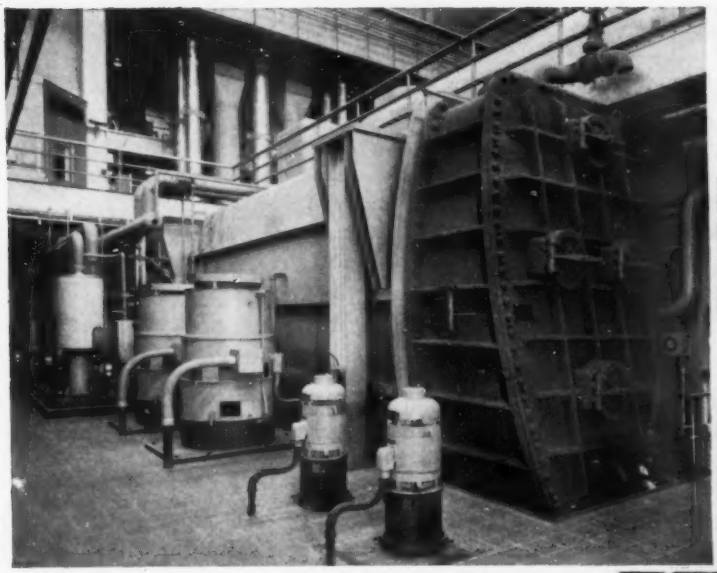
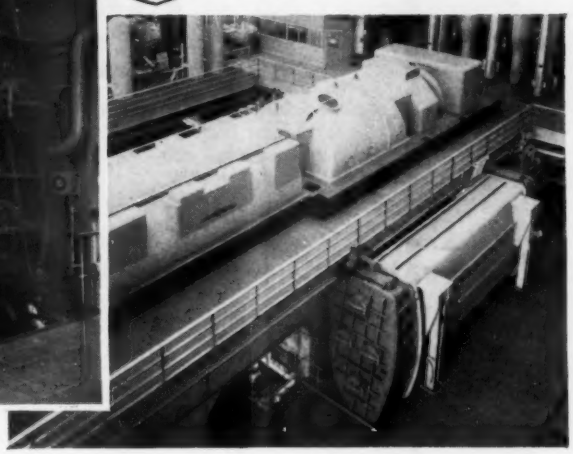


saves headroom and construction costs at Kearny Generating Station



One of the FW side-mounted condenser shells from basement level, showing deflection columns, condensate pumps and heater drain pumps.

General view of turbine room at Kearny station, showing one of the twin condenser shells and the side-exhaust turbine.



The slightly unorthodox surface condenser illustrated above is one of two 70,000 sq. ft. side-turbine-exhaust units designed and built by Foster Wheeler for Public Service Electric and Gas Company, N. J. Serving a 145,000 kw turbo generator at the new Kearny Generating Station, it has effected important overall economies in station construction.

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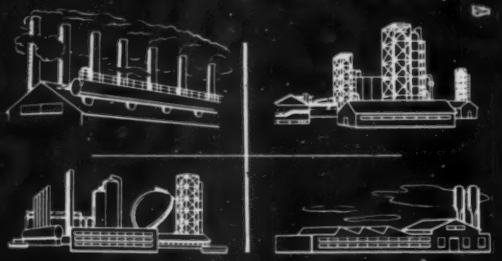

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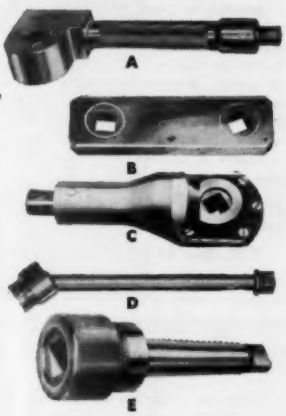

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2000 or 2500 K.W. 3 ph. 60-480 V. turbo gen. set for 185 to 200#-0-10# BP also
TWO Packard Model 4M 2500 or TWO Sterling Admiral oil engines.

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POWER
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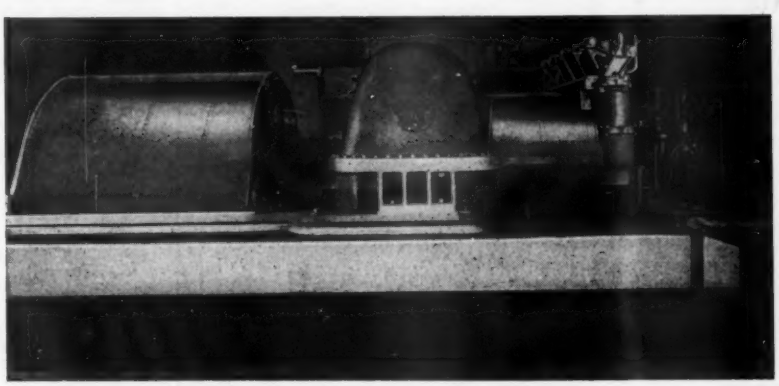
3750-KVA. ALLIS-CHALMERS-400# PSIG, 750° F.T.T. TURBINE-GENERATOR NEW 1948-EXCELLENT CONDITION

Above view of our Allis-Chalmers 3750 KVA Condensing Turbine Sets, just released, offered here for the first time. Is complete with 2-pass Surface Condenser capable condensing 34,500# steam per hour, Switchboard with Instruments, Exciter direct connected and has had limited service and ready now for immediate delivery. Voltage: 3/60/2300/4160 Volt. Steam Pressure: Initial 400# PSIG, 750° F.T.T.

OTHER UNITS AVAILABLE:

1—2000 KW Gen. Elect. Cond.—440#—750° F.T.T.—2300 V.
1—2000 KW Al.-Chal. Cond.—400#—750° F.T.T.—2300 V.
1—1500 KW Gen. Elect. Cond.—410#—750° F.T.T.—2300/4160 V.
1—2000 KW West., Non-cond.—250#—600° F.T.T.—40# B.P., 2300 V.
1—1250 KW West., Non-cond.—150#—600° F.T.T.—15# B.P., 2300 V.
1—1250 KW Gen. Elect., Non-cond.—200#—600° F.T.T.—15# B.P., 480 V.
2— 750 KW West., Non-cond.—150#—600° F.T.T.—15# B.P., 2300 V.

3750-KVA. G. E., 400#, 750° F.T.T. TURBINE-GENERATOR



Above view was made from a recently taken photograph of the 3750-KVA, G.E., Turbine. It is a condensing machine complete with 2-pass, 6000 sq. ft. Surface condenser, Switchboard with instruments, D.C. Exciter. Voltage is 3/60/2300-4160-V.

MACHINE CAN BE INSPECTED IN OPERATION

We own and offer any Capacity Turbine from 300-KW to 12,500-KW. Complete line of Boilers, also Diesel Engines. Send us your specs.

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OIL CIRCUIT BREAKERS

3—600 AMP. G. E. FKR-55-20, 15,000 V.
3 P. 100,000 KVA, SOLENOID OPER.

TRANSFORMERS—60 Cycle

Qu.	KVA	Make	Type	Ph	Voltages
2	3750	G.E. new	OISC	3	26,400x4360
1	1000	G.E.	Auto	3	4150x2400
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600-120/240
1	500	Kuhl.	OISC	1	4150x2400
2	400	Pitts.	OISC	1	4800/4150/2400 x240/480
1	333	G.E.	H	1	13200x220/440
2	300	G.E.	H	1	13200x440
4	200	G.E.	H	1	13200x440
1	200	G.E.	HT	3	2400x240
2	150	Pitts.	ODSC	1	240x120/240
3	50	G.E.	H	1	4800x120/240
3	50	A.C.	H	1	230x120/240
3	50	G.E.	H	1	460x115/230
3	50	Whse. new	OISC	1	2400/4160x240/ 480
3	37½	G.E.	H	1	2400/4160x120/ 240
1	25	G.E.	H	1	460x120/240

SLIP RING MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	ou	CW	440
2	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
3	60	G.E.	1800	MT	220

DC, 230 VOLT MOTORS

Qu.	H.P.	Make	Speed	Type
1	300	G.E.	1200	MPC
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
2	75	C.W.	900	WP
1	30	C.W.	700	CM
1	25	G.E.	800	RC
1	25	Whse.	835	SK

SQUIRREL CAGE MOTORS

Qu.	Make	Speed	Type	Volts
150	G.E.	720	KT	440
125	G.E.	3560	KF	2300
100	G.E.	1200	PTR	220
75	Ideal	1200	AT	220/440
60	G.E.	1200	KT	220
50	G.E.	3560	FT	220
50	G.E.	600	KT	440
40	G.E.	3550	FT	440
30	G.E.	600	KT	440

MOTOR GENERATOR SETS

Qu.	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 Syn.
1	1000	Whse.	720	600	2300/4150 Syn.
1	750	Whse.	720	275	2300/4150 Syn.
1	300	C.W.	1200	230	3-unit 2400/4150SR
1	300	G.E.	1200	230	2400/4150SR
1	200	Whse.	900	250	2300/4150 Syn.
1	150	C.W.	1200	230	440 SC
1	150	3 Unit G.E.	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	C.W.	1200	125	2300 S.C.
1	100	G.E.	900	250	2300 Syn.
3	60	G.E.	1200	125	208 Syn.
2	30	G.E.	1200	125	440 SC

SYNCHRONOUS MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	300	El. Mach.	720	TEFC	2200
3	200	Whse.	720		4150
1	175	G.E.	720	ATI	2300
1	150	G.E.	720	ATI	2300
1	150	G.E.	1800	TS	220
1	150	Whse.	900	ISIG	220

SPECIAL

A.C. Welding MG Set

176 KVA 1200 RPM 1 Phase 220 V. 800 Amps. 57 PF motor 1160 RPM. 440 2 3 Ph. S.R. direct connected exciter and flywheel.

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55 CFM Lindsay (GAS)
66 CFM LeRoi—CPT—Worth (GAS)
105 CFM Joy—Worth—CPT (GAS)
160 CFM Worthington (GAS)
210 CFM Worthington (GAS & DIESEL)
270 CFM Sullivan w/Buda Power Unit—Skids
315 CFM Worthington (GAS & DIESEL)
500 CFM Worthington (DIESEL)
600 CFM Worthington (DIESEL)

STATIONARY

80 CFM 6 x 5 Worthington HB—10 HP Elec
122 CFM 7 x 7 Worthington HB—20 HP Elec
165 CFM 60 PSI 8x7 Penn AT
168 CFM 135 PSI 8x9 CPT—TB
173 CFM 9x8 IR—CPT—Penn.
294 CFM 125 PSI 10x11 Worth—HB
311 CFM 9 x 8 Ingersoll—ES-I—40 HP Elec
364 CFM 20 PSI 12 x 7 Gardner Denver
368 CFM 100 PSI 12x10 IR—ERI
594 CFM 20 PSI 15x9 Worth—HB
905 CFM 55 PSI 17x13 CPT—TB
1085 CFM 35 PSI 20 x 12 Pennsylvania
1452 CFM 70 PSI 15/15 x 14 Penn Duplex

MANY OTHERS TO CHOOSE FROM

VACUUM PUMPS

354 CFM 14 x 5 Penn—15 HP
434 CFM 14 x 7 Ingersoll 15-20 HP
720 CFM 18 x 7 Worthington 25-30 HP
1184 CFM 22 x 9 Chicago 40-50 HP
1633 CFM 24x11 Chicago 60 HP
4020 CFM 30 x 12 (D) Ing. Rand XVH

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REBUILT—GUARANTEED ELECTRICAL EQUIPMENT

Several Larger Items Selected from Our Stock

MOTOR GENERATOR SETS

Qu.	KW.	Make	R.P.M.	Volts D.C.	Volts A.C.
1 (3-U)	2400	Whse.	720	600	4800/2400
2	1200	Whse.	720	600	2300
1	500	C.W.	720	275	2300/440
1	400	C.W.	1200	125/250	440
1	300	G.E.	720	275	2300
2	200	G.E.	720	250	2300/440
1	150	G.E.	720	250	2300/440
1	100	Whse.	900	275	2300
1	100	C.W.	1200	125	440/220
1	85	C.W.	1200	250	4000/2200

SYNCHRONOUS MOTORS
3-Phase, 60-Cycle

Qu.	h.p.	Make	P.F.	Volts	R.P.M.
1	3000	Whse.	.80	4800/2400	720
2	2100	G.E.	1.00	2300	360
2	2000	G.E.	.80	2200	720
1	800	El. Mchy.	.80	440	1200
1	750	G.E.	.80	2300	450
1	300	G.E.	.80	440/220	900
1	250	G.E.	1.00	2300	514
1	250	Whse.	.80	440	600
2	200	Whse.	.80	440	1200
1	187	G.E.	.80	440	720
1	150	Whse.	.80	440/220	450
2	135	G.E.	.80	4000/2200	1200

TRANSFORMERS

Qu.	KVA	Make	Phase	Voltage
3	750	Pitts.	1	23,000-2300
3	667	Wagner	1	22,000/11,000-2300/4000
3	500	G.E.	1	22,000/11,000-2300/4000
3	333	G.E.	1	13,200-2300
3	250	G.E.	1	2400-240/480
2	150	G.E.	3	2400/4150-240/480
3	100	G.E.	1	33,000/2300

T.B. MAC CABE COMPANY

FOR SALE

(5) OIL FIRED B&W BOILERS
75,000 lbs. per hour—11,147 sq. ft. heating surface — 200 lbs. working pressure. Cross drum—sectional header—30 sections wide. IN EXCELLENT CONDITION. LOCATED BALTIMORE, MD.

(2) EX-LIBERTY SHIP BOILERS
24,000 pounds per hour—4890 sq. ft.—225 pounds working pressure. Made by Combustion Engineering Co.

(3) SCOTCH MARINE BOILERS
225 pounds working pressure. Approximately 17,500 pounds each, per hour. 1943.

(4) 300 KW G.M. 8-268A DIESEL GEN.
G.M. diesel generator sets—120/240 volts DC—1200 RPM—1250 amps.—8 cyl. 6½x7—with switchgear.

(6) 300 KW TURBO GENERATOR SETS
120/240 volts DC—Joshua-Hendy turbine—250 lb. W.P. condensing. Suitable for pressures to 440 lbs. at 740°TT. Geared to 1200 RPM. 300 KW Westinghouse 120/240 volt 1250 amp. stabilized shunt generator. With switchgear. Built 1945. Excellent condition.

COCHRANE DEAERATOR
220,000 lbs./hr.—1800 gal. storage volume—max. pressure 20 lbs.

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30" & 36" Wide Belt Conveying Equipment
30 & 80 HP Erie Economic Boilers
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Robins H.D. Car Shakeout w/motor
5—84"x20' Erie City HRT Boilers
5'x67' & 8'x125' Rotary Dryers
85'x4' dia. x ¼" Steel Stack
10 Ton 50' Span OET Crane AC Mtrs.
H. & P., 6719 Etzel, St. Louis 14, Mo.

RE-NU-BILT
GUARANTEED
ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	HP	Make	Type	Volts	RPM
1	2200	G.E.	MCF	600	400/500
1	2000	Whse.	Mill	600	230/460
1	1200	G.E.	MCF	600	750/950
1	940	Whse.	QM	250	140/170
1	900	Whse.		250	450/550
1	825	Whse.		250	95/190
1	600	Al. Ch.		250	400/800
1	500	Whse.	CC-216	600	300/900
1	500	G.E.	MCF	600	300/900
2	450	Whse.		550	415
1	200	Whse.	CB-511.3	250	400/800

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G. E.	MT-498	2300	360
1	1500	ABB		2300	720
1	1200	G. E.	MT	2300	275
2	1000	A. C.	Mill	2300	240
1	1000	G. E.	MT-452	2200	321
1	500	G. E	M-574Y	6900	900
1	500	Whse.	CW	550	350
1	450	G. E.	IM	440	720
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G. E.	MT-442 Y	2200/4000	253
1	350	G. E.	IM-17A	440/2200	720
1	250	G. E.	MT-459Y	4000	257
1	250	G. E.	MT-559S	2200	1800
1	250	Al. Ch.		550	600

SQUIRREL CAGE

2	650	G. E.	FT-559BY	440	3570
2	450	Whse	CS-1420	2300/4150	354
1	300	Whse.	CS	440	1170
1	200	G. E.	IK-17	440	580
3	200	G. E.	KT-557	440	1800
1	150	Whse.	CS-856S	440	880
1	150	Whse.	CS	440	580
1	150/75	G. E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C. W.	3501-SL	13800/6900	514
2	2100	G. E.	ATI	2300	360
2	1750	G. E.	ATI	2300	3600
2	2000	Whse.		2300	120
3	735	G. E.	ATI	2200/12000	600
1	720	G. E.	TS	2300/4600	720
1	500	Ideal	SM	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2200	1285
1	450	Whse.		2200	450
1	400	G. E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G. E.	450	250/300	2300/4600
2	2000	G. E.	450	600	2300/4600
1	2000	G. E.	500 25cg	660	11000
2	2000	G. E.	514	600	6600/13200
1	1500	G. E.	720	600	6600/13200
1	1500	C. W.	514	30/115	4000/13000
3	1000	G. E.	720	600	2300/4600
1	1000	G. E.	900	260	6600
1	1000 3U)	G. E.	900	250	2200
1	750	C. W.	514	30/115	2300
1	600	G. E.	720	250	440/2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	5000	Whse.	OISC	3	3300x2640
1	2500	Whse.	OISC	3	26400/13200x46
3	2000	G. E.	HVDDJ	1	66000/13800
3	667	G. E.	HD	1	13800x2300
3	1000	G. E.	HVDDJ	1	2400x480
6	1000	Wagner	OISC	1	13200x46

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	3000	G. E.	60/25	2300/2300/4000
2	2500	G. E.	25/62.5	2300/2300
1	1000	G. E.	25/58.3	4400/2300
1	500	Al. Ch.	2560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G. E.	Condensing 425—750 F. T. T. Surface Condenser 3/60/2300/4000 V Direct conn exciter
1	1500	Whse.	Auto-extraction 190 lbs.—600° F.T.T. 60 lb. extraction 3/60/240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G. E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P., 480/3/60.
1	750	G. E.	Condensing 265# I.S.P. 440V, 3 ph. 60 cy.—New—1944.
1	750	Whse.	—Non-condensing 15# I.S.P. 40# B.P. 750 Kw. 280 V. D.C.

BELYEA COMPANY, INC.
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NOW IS THE TIME TO BUY....
"Certified Rebuilt" Motors and Generators
HIGHEST QUALITY . . . REDUCED PRICES
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A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
625	El. Machy.	Late	240/480	1200
485	Allis Ch.	1 brg.	480	400
350	El. Machy.	1 phase	480	1200
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	Allis Ch.		240/480	1200
150	Gen. Elec.	ATB	2300	900
150	Whse.		2300/480	600
125	El. Machy.	Syn.	240/480	1800
125	Gen. Elec.	ATB	240/480	900
112	Gen. Elec.	ATB	240/480	900
75	El. Machy.		2300	900
58	G. E.	ATB	240/480	1200
25	Whse. b.b.	1 phase	120/240	900
10	Kato b.b. New	3 phase	127/220	1800

LOW VOLTAGE M-G SET
Whse. 3636 amp. 20/55 V DC gen. w/synch. motor 220/440 V. 720 RPM and exciters.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis. Ch. b.b.	EW	350	1200
250	Gen. Elec.	MPC	250	600
175	Allis Ch. b.b.	EW	250	900
150	Gen. Elec. b.b.	CDM	250	1500
125	Whse.	SK	250	1450
105	Century b.b.	1500 amp.	70	1200
100	Allis Ch.	E	125	1200
100	Allis Ch.	EI82	250	900
100	Delco b.b.	Mar.	125/250	1200
75	Cont. b.b.	D109X	125	1150
75	F. M. b.b.	DH	125	1800
75	G. E. b.b. (2)	CDM135	125	750
75	Whse.	SK	250	900
75	Columbia b.b.		120/240	1450
60	Allis Ch.	E147	250	900
60	Whse. b.b. (2)	SK121	300	1200
50	Cr. Wh. b.b.	CCD	250	1800
50	Reliance	T	250	1150
40	Gen. Elec.	CD103	250	1500
40	Gen. Elec.	RC	600	1750
35	Gen. Elec.	RC31B	240	1750
25	Whse.	SK93	125	1750
25	C. W. b.b. (2)	CCD	250	1200
20	Gen. Elec.	RC	125	1150

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	350	1000
300	Gen. Elec.	MPC	250	500
300	Allis Ch. b.b.	MCF	600	300/700
200	Allis Ch. b.b.	EW	250	650
150	Whse.	SK-261	230	300/900
100	Allis Ch.	E182	230	600/1200
75	F. Morse b.b.	DH-140	115	1800
75	Whse.	SK173	230	635
50	Whse.	SK173	230	300/1200
50	Reliance	310T	230	850
50	Reliance b.b.	651T	230	750
50	Cr. Wh. b.b.	FH	230	1750
50	Whse.	SK185	230	300/900
40	Whse.	SK143	230	600/1500
40	Reliance	651T	230	350/1000
40	Allis Ch.	E-121	230	1750
40	Gen. Elec. (2)	CD103	230	1150
40	Gen. Elec.	RC32	550	1200
30	Imperial b.b.	D69	230	400/1600
30	Star b.b. (3)	SB	230	1750
25	Star b.b.	SB	230	1750
25	L. A. TEFC	RNA	230	850
25	Whse.	SK150	230	300/1200
25	Gen. Elec.	CD105	230	575/1720
25	Whse.	SK100L	230	1150
20	Century b.b.	DN326	230	3500
20	G. E. series	CO-1826	230	875
20	Allis Ch.	E-100	115	1150
15	G.E. (2)	CD75	115	1750

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	G. E.	Synch.	2200	514
600	E. M.	Synch.	480	1200
550	G. E.	Sq. Cage	2200	3600
500	G. E.	Sq. Cage	4000	1800
500	G. E.	Slipring	2200/440	450
500	G. E.	Synch.	440	900
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	G. E.	Synch.	440	450
400	Allis Ch.	Sq. Cage	2200/440	1200
350	Whse.	Slipring	2200/440	600
350	Whse. (2)	Slipring	2300	450
350	G. E. TEFC	Sq. Cage	2200/440	3600
300	G. E. (2)	Slipring	2200/440	720
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2200/440	720
300	Whse.	Synch.	2200/440	600
300	Al. Ch.	Slipring	2300	514
300	G.E.	Slipring	440	360
250	G.E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2200/440	1200
250	L. A. (2)	Sq. Cage	2200	1800
225	G. E.	Synch.	220/440	900
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	G. E.	Slipring	220/440	600
200	E. M.	Synch.	220/440	1200
200	G. E.	Slipring	220/440	360
200	Whse.	Sq. Cage	220/440	1800
200	E. M.	Synch.	220/440	514
200	Wagner	TEFC	2200	1200
175	G. E. (2)	Synch.	220/440	720
175	Whse.	Synch.	220/440	360
150	Whse.	Sq. Cage	220/440	900
150	G. E. TEFC	Sq. Cage	2200	3600
150	Allis Ch.	Slipring	2200/440	720
150	G. E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2200/440	720
150	G. E. (2)	Sq. Cage	2200/440	720
150	G.E.	Slipring	220/440	450
150	Allis Ch.	Sq. Cage	2200/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G. E. (2)	Slipring	220/440	600
125	G. E.	Slipring	220/440	450
125	F. M.	Synch.	220/440	1800
125	Allis Ch.	Slipring	220/440	900
100	Burke b.b.	Synch.	220/440	1800
100	G. E. New	Slipring	220/440	1200
100	G. E.	Slipring	220/440	900

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
1000	G.E.*	6600 AC	600 DC
500	Whse.*	2300 AC	250 DC
300	G. E.*	440 AC	250 DC
300	Allis Ch.	2200/440 AC	125/250 DC
250	Allis Ch.	2200/440 AC	250 DC
200	Whse.* (2)	220/440 AC	55 DC
200	G.E.*	220/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
150	Whse.	2200/440 AC	275 DC
105	Century b.b.	220/440 AC	70 DC
100	G. E.*	2200/440 AC	125 DC
100	Allis Ch.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	125/250 DC
80	Star* b.b.	220/440 AC	240 DC
60	Gen. Elec.*	220/440 AC	80 DC
60	Whse. (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b. (3)	220/440 AC	240 DC
40	G. E. (2)	220/440 AC	250 DC
40	Gen. Elec.	220/440 AC	600 DC
30	F. Morse b.b.	220/440 AC	24 DC
25	Whse.	220/440 AC	125 DC
25	Gen. Elec.	220/440 AC	250 DC
15	El. Prod.	220/440 AC	40 DC
15	Star b.b.	220/440 AC	250 DC
12	M.C. b.b.	220/440 AC	125 DC

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POWER EQUIPMENT FOR ALL INDUSTRIAL NEEDS

D. C. Motors — 230 Volt

H.P.	Make	Type	Speed
250	Westg.	SK-220	450/600
250	Westg.	SK-201	650
200	Cr. Wh.	CM	560
175	G. E.	ELC	730
100	G. E.	MPC	400/800
100	G. E.	RC-34	2500
100	G. E.	CDP-115	1750
100	G. E.	RC-19	575
100/150	G. E.	MCF	380/1000
75	G. E.	RCP-34	1750
50/120	G. E.	MCF	250/1000
50	G. E.	RC-31B	1700
50	Cr. Wh.	CMC	700/1100
50	G. E.	DLC-204	650
35	Westg.	SK-150	350/1000
30	Cr. Wh.	CCM-504	450
30/40	G. E.	CD-115	500/1500
25	G. E.	RC-32	800
25	Westg.	SK-133	575
20	Star	SB-10	1750
20	Westg.	SK-1106	750
15	Westg.	SK-103	400/600
10/15	Reliance	185T	400/1600

SQUIRREL CAGE MOTORS

3 Phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	Make	Type	Speed
1250	*Al.-Ch.	ANW	1200
800	*Westg.	CB	3600
800	*Westg.	CS-1485	1800
700	Al.Ch.	AN	900
500	*Al.-Ch.	6316-SW	1800
500	G.E.	KT-424	450
400	G.E.	KP-539	3600
400	G.E.	KT-424	360
350	Ideal	A	1800
300	*G. E.	K-6344Y	1200
300	G. E.	K-6353 TEFC	720
250	*L-Allis	OEX-148	720
250	*G. E.	IK	600
250	G. E.	IK-17A	600
200	*G. E.	FT-549Y	3600
200	*G. E.	IK-13B	1800
200	*Al.-Ch.	AN	720
200	Al.-Ch.	ARWWT	585
200	*Westg.	CB	600
200	G. E.	IK-17	600
200	G. E.	K-6352	514
150	G. E.	IE-12A	1800
150	G. E.	IE-12B	1200
150	*Westg.	CS-812 S TEFC	1200
150	G. E.	K-6634	900
150	Westg.	CS-876C TEFC	900
150	*Westg.	CS	600
125	Westg.	CS-771 Sppf.	1200
125	*Al.-Ch.	AR	1800
125	Al.-Ch.	AR-226 CS	1800
125	*Reliance	AA 6085	900
125	Al.-Ch.	AN	900
100	L-Allis	114S-Ex. Pr.	3600
100	Westg.	CS-505S TEFC	3600
100	Westg.	CS-607S TEFC	3600
100	*Westg.	CB	1800
100	*G. E.	FT-542Z	1800
100	G. E.	FT-RF-543	1800
100	G. E.	K-5048	1800
100	G. E.	KT-543	1800
100	*Westg.	CS-769D	1200
100	G. E.	IK	1200
100	Al.-Ch.	ANW-23D	1200
100	*Westg.	CS (Vert)	1200
100	U. S.	CFU (Vert)	1200

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	Make	Type	Speed
1500	*G. E.	MT-30	240
1250	*Westg.	CW	600
1000	*Westg.	CW	250
700	*Al.-Ch.	ANY	720
600	G. E.	MT-567	1800
600	*Westg.	CW	450
600	*G. E.	I-P	257
500	Westg.	CW	350
400	Al.-Ch.	3 brg.	450
400	*G. E.	MT-412	450
300	*G. E.	IE-15A	1800
300	*G. E.	MT-568	720
250	Westg.	HP-15H	600
200	*Westg.	CW	1200
200	G. E.	IK-15B	900
200	G. E.	IM	600
150	Cr. Wh.	50-R	1800
150	G. E.	MT-549	1800
150	*Al.-Ch.	ANY-30F1	1200
150	Westg.	CW-868A	720
125	G. E.	IM-15A	600
100	G. E.	IT-13A	1800
100	G. E.	IM	600
100	G. E.	IM	450
75	Nor. Wes.	HW-50	1800
75	G. E.	MT-347	1200
75	G. E.	IM	1200
75	Al.-Ch.	ARY-223C	1200
75	G. E.	MT-356	900
75	Al.-Ch.	ANY-26F	900
75	Westg.	CW-766A	900
75	*Al.-Ch.	ARY	720
75	G. E.	IM	600
75	Westg.	CI-756A	600
60	*Westg.	CW-762A	900
50	*Al.-Ch.	ARY-220-BS	1800
50	G. E.	IM	1200
50	*Al.-Ch.	ARY	1200
50	Westg.	CW-636A	1200
50	Westg.	CW-658A	900
50	G. E.	MT-536	900
50	G. E.	MT-346	720
50	Westg.	MW-334	600
50	Al.-Ch.	ANY-26F	600
50	G. E.	HIC-TENV	600
50	G. E.	IM	450

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volt (*2300 volts or higher)

H.P.	Make	Type	Power Factor	Speed
1420	*West.		.7	900
730	*West.		1.0	900
710	*G.E.	ATI	1.0	720
600	*G.E.	TS-7640	1.0	900
500	*G. E.	TS-7657	1.0	514
400	*West.	H	.8	1800
400	West.	HG	1.0	900
300	G. E.	ATI	.8	900
300	G. E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G. E.	ATI	.8	1200
250	G. E. (New)	TS-974Y (3 brg)	.8	720
225	G. E.	TS-6244	1.0	300
225	Elec. Mach.		1.0	360
200	Fair-Mor.	TJC-285	.8	720
190	Elec. Mach.		1.0	720
150	Fair-Mor.	TJC-285	.8	720
150	G. E.	ATI	.8	720
150	*Elec. Mach.		.8	1200
150	Westg.	HR	1.0	300
125	*G. E.	TS-7641	1.0	514
125	*G. E.	TS-6214	1.0	277
125	*Elec. Mach.			900
115	Elec. Mach.		1.0	240
100	Westg.		1.0	900
100	Ideal	SNS	1.0	900
15	Ideal	FRS	1.0	1800
15	Century	ARC-365	1.0	1200
7½	Ideal	FRS	.8	1800

SPECIAL GEAR MOTORS

2—30 H.P. Westinghouse, Type CS-404, 3/60/220-440/TEFC, 1800 rpm with Falk Class 2-9.394 ratio reducer —190 rpm output.

CHICAGO *Electric Co.* 1320 WEST CERMAK ROAD, CHICAGO 8, ILL.

FOR SALE:

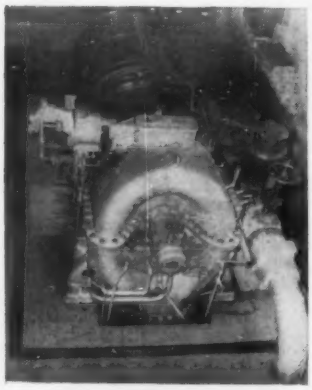
1250 KW Turbogenerator consisting of—

1 Curtis Steam Turbine—1250 KW—3600 RPM Form C—3 Stage—275 lb. steam pressure, Condensing. Manufactured by General Electric Co.

1 AC Generator—2300 Volt—3 Phase—60 Cycle, 80% Power Factor—1250 KW—3600 RPM. Manufactured by General Electric Co.

1 2750 Sq. Ft. Westinghouse Electric Mfg. Co., Surface Condenser.

The above to be sold as is, F.O.B., Foundation at our plant at Perry, N.Y., and to be sold as a complete unit.



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1—M.G. SET as follows—

Motor—40 H.P.—220 Volt, 3 Phase, 60 Cycle, 870 RPM, General Electric Co.

Direct connected to DC Generator—Westinghouse Electric Mfg. Co., 125 Volt—360 Amp—850 RPM.

THE PERRY KNITTING CO. PERRY, NEW YORK

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2—NEW, I.R., 3580 CFM @ 110 PSI

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2—30 & 8 x 22, I. R., Type PRE-2 Compressors, 5 step control, 200 RPM, with direct connected G.E. Synchronous Motors 600 HP, 3/60/4160 unity P. F., G. E. full voltage magnetic controllers, 10 KW, M. G. Sets for excitation,, aftercoolers, and automatic condensate traps.

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W. U. WIRE • CABLE — AGSCOMACH

PORTION OF ENGINE REMANUFACTURING FLOOR AND ONE OF THE ENGINE TEST STANDS AT OUR SAUSALITO, CALIF. PLANT

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
600	General Motors	12-567	900	600
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*400	Ingersoll-Rand	S-8	600	720
*400	Sterling	VDS-8	600	1200
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
150	Fairbanks Morse	338-17	225	300
*150	Worthington	CC-4	225	450
150	Ingersoll-Rand	S	255	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

ALTERNATING AND DIRECT CURRENT UNITS
STANDARD AND SPECIAL VOLTAGES AS REQUIRED
**—indicates NEW unit*

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DIESEL GENERATOR SETS

3—1400 HP Superior 8 cyl. 360 RPM 1000 KW Elec. Mchy. 3/60/2400 volt generators. Complete Plant. New 1949.

2—750 HP Superior 8 cylinder, 400 RPM, 500 KW Elec. Mchy. 3/60/440 volt generators & auxiliaries.

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Custom-built transformers and coils manufactured to your specifications.

Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned. Ask for our price schedule.

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5331 Hetzel St. Cincinnati 27, Ohio
40 Years' Dependable Service

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2 American Marsh Steam Vacuum Pumps—Size 25" x 16" x 20"—In Perfect Condition. Price: $800.00 ea., F.O.B. Washington, D.C.

S. E. DOCKSTADER, INC.
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FAIRBANKS-MORSE DIESEL PLANT

2—120 HP F.M. Model 32E12, 2 Cyl., 2 cy., 12" x 15", 360 RPM, engines. Direct conn. to: 96 KVA F.M. A.C. Alternators, 3/60/120/240 V., with belted Exciters, and accessories.

ALJON ELECTRIC DIESEL CO.
904 Pacific St. Brooklyn 38, N. Y.
STerling 3—6515

2—1000 KVA-3-60-12000-240/480 V. NEW Westinghouse Power Centers with primary and secondary switchgear.
4—100 KVA-3-60-2400-120/208 V. Pyranol transformers each with 275 A, 600 V. 3 pole air breaker.
1—150 HP-900 rpm-440-3-60 GE synchronous motor exciter and automatic starter.
1—100 HP-870 rpm-440-3-60 NEW Elec. Mach. Mfg. Co. Magnetic Drive and Regutron Control.
H. BLAINE JOHNSON & ASSN.
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25000 KVA AUTOTRANSFORMER

General Electric, Type HT, Form DD, 60 cycle, 3 phase serial 4126955, 0.812% impedance, 55° C. continuous, circular coil design, voltage rating—69300 Primary, 66000 Second. KVA rating as a two winding transformer—2500 KVA—with any voltage combination from 66 KV to 2.4 KV.

Some Possible Ratings as an Autotransformer on Standard Voltages

PRIMARY KV	SECONDARY KV	KVA RATING
67	43.8	6500
67	34.4	4650
67	22.9	3450
34.4	22.9	6800
34.4	13.8	3750
34.4	13.2	3700
34.4	12.47	3550
34.4	12.0	3500
22.9	13.8	5700
22.9	13.2	5400
22.9	12.47	5000
22.9	12.0	4750
22.9	8.32	3550
22.9	7.2	3350
13.8	7.2	4750

We Will Rewind This Transformer To Your Specifications

BOILERS
1—350 HP Hedges-Walsh Weidner 225 psig

DIESEL GENERATORS
1—300 KVA Superior YLO—G.E. Gen 400 rpm 2200/440/3/60

TRANSFORMERS—1 PHASE 60 CYCLE
3—3333 KVA 66000 to 33000 & 13200 v.
1—1000 KVA 33000/11000/2300
2—1000 KVA 13800—2300 v.
3— 500 KVA 38100/66000 Y—2300 v.
3— 500 KVA 33000 v.—2300 v.
4— 500 KVA 13200 v.—2300 v.
4— 200 KVA 33000 v.—2300/4160 Y
5— 200 KVA 13200—2300/4160 Y
1— 200 KVA 12000—2300/4160 Y
3— 200 KVA 7620/13200 Y—2300
1— 150 KVA 6600—2300/4160 Y

TURBO GENERATORS
1000 KW West. Cond. 185 lbs 100 SH 3/60/2300
1500 KW G.E. Non-Cond. 140 lbs. 3/60/2300
1000 KW G.E. Non-Cond. 140 lbs. 3/60/2200

PUMPS—BOILER FEED
600 GPM 1220' hd. DeLaval 3550 RPM Requires 250 HP
600 GPM 1220' hd. Conn. 233 HP 3550 RPM 400 lb. pres. DeLaval turbine
400 GPM 1250' hd. Worth. 1750 RPM 5" x 4"

GENERATORS—GAS ENGINE
99¾ KVA 230/3/60 Star Buda with charger
66½ KVA 240/3/60 4 wire Waukesha-Bardco Type C12 truck mounted

SYNCHRONOUS MOTORS
400 HP 1800 RPM 2200 volts Westinghouse .8 PF
300 HP 400 RPM 2200/440/3/60 G.E.

CENTRIFUGAL PUMPS
5200 GPM 55' hd Worthington 18 x 14, 1150 RPM 100 hp required.
5000 GPM 214' hd Pennsylvania 15½ x 14, 1775 RPM 300 HP required.
4375 GPM 100' hd. DeLaval 14 x 12, 1270 RPM
3500 GPM 37' hd DeLaval 12 x 12, 1160 RPM 50 HP required.
3200 GPM 50' hd Gardner Denver 10 x 12, 1160 RPM 60 HP required.

AIR COMPRESSORS
570 CFM 17 x 12, 55 psi, single stage Ingersoll-Rand Type ERI, 85 hp
335 CFM 14 x 10, 100 psi single stage Ingersoll-Rand Type ERI, 100 hp.

TAMPA ARMATURE WORKS INC.
401 S.MORGAN ST. TAMPA, FLORIDA PHONE 2-1966

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AUTOMATIC EXTRACTION

2—1563 KVA General Electric Automatic extraction condensing, 6 stage, 165/300 lbs. steam pressure, 700 deg. F.TT, 10 lbs. extraction. 3 phase 60 cycle 480 volts, 3600 RPM. Equipped with switchboards, surface condensers and auxiliaries.

IGNITION MERCURY
ARC RECTIFIER

2000 KW General Electric ignitron, 630 volts, 3175 amperes D. C., 6 phase, 60 cycle A.C. Equipped with 2260 KVA rectifier transformer, OISC, 3 phase, 60 cycle, 12500-13200 volts primary; cubicle and drawout switchgear, rectifier automatic and auxiliary control equipment and accessories. Suitable for railway or electro-chemical application.

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Electrical Equipment of All Kinds
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30 TON BRIDGE CRANE

65 ft. span—Northern Engineering Co. Fish belly fabricated—travel motor—trolley motor—30 ton hoist—15 ton auxiliary hoist motor. All 230 volt DC motors—mfg. by G.E.—cab controlled with G.E. controls. Can be seen in operation.

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2—B & W STERLING WATER TUBE BOILERS

Class 111-M-30—4 drum ASME 350 lb working pressure fitted with foster wheeler water cooled walls, induce draft and force draft, 8600 sq ft heating surface, used only 4 years sell at a bargain.

AMERICAN MACHINE CO.
PO Box 661, Oakland, Calif.

FOR SALE
18 NEW TURBINES
4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
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FOR SALE
MODERN DIESEL
ENGINE GENERATOR

Practically new 600 KVA Heavy Duty Worthington, 3 ph., 60 cycle, 2400 Volts, complete with Auxiliaries.

SUNDFELT EQUIPMENT CO., INC.
220 Hudson St., Seattle 8, Wash.
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2—500 K.W., G.E. NON-CONDENSING TURBO GENERATORS

175 ISP, 18# back. 600 volts, 3 phase, 60 cycles.

3—AIR COMPRESSORS
680 CFM, 20x12—25 Lbs air, I.R.
576 CFM, 16¼x12—25 Lbs air, I.R.
88 CFM, 100# air, West'g Air Brake.

Available due to plant changeover
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O'Brien Offers—

MOTOR GENERATOR SETS

1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW Ridgway 250 V. 3/60/2300/1200 rpm
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
2—180 KW G.E. Frequency Changers 60/120 cycle
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
1—100 KW G.E. RC 17, 125 v. 3/60/220/1200 rpm
1—100 KW Electro Dynamic 200 V. 3/60/220/1200 B. Brg. Sq. Cg. Sep. Excited.
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—100 KW West SK Comp'd 125 V., 150 HP West syn. 3/60/440/1200 rpm.
1—75 KW Burke 250 V. 900 RPM 113 H.P. Burke—Syn. M.D. 2 or 3 ph, any voltage.
2—70 KW Century, 1000 amp, 70 volt, 3/60/220/440
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
2—50 KW GE 500 Volt DC, 75 HP, 3/60/40/1200 RPM.
1—18 KW Optimus, 3000/1500 amp 6/12 volt
1—17 KW West., 28 v. 60 amp 3/60/220
1—6 KW G.E. 6 v. 100 amp, 3/60/220

DIESEL GENERATOR SETS

3—625 KVA Inger. Rand, 3/60/480/720 rpm
375 KVA GM 8-268 Diesel 3/60/440
300 KW GM 8-268 Diesel 125/250 V. D.C.
187 KVA GM Twin Diesel 3/60/220 New
125 KVA Waukesha Diesel 3/60/220-440
100 KW Buda Diesel 250 V. D.C.
100 KVA Murphy Diesel 3/60/220-440
65 KVA Buffalo Gas 3/60/220
56 KVA Climax Gas 3/60/220
45 KVA Chrysler Diesel 3/60/220
30 KVA LeRoi Gas 3/60/220
25 KVA LeRoi Gas 1/60/120/240
18.75 KVA Hercules Diesel 1/60/120/240

BOILERS

1—60,000# Erie Stoker New 160 psi
1—610 HP Keeler 3 Drum Bent Tube Pulverized Coal 32,000 lb. 1 HR 250 lb. W.P.
1—350 Cleaver Package Heavy Oil 150 lb. W.P.
1—300 HP Keeler CP 300 lb. Oil
1—250 HP Ames Package Type (1948) 150 psi
2—200 H Springfield Sec. H. dr. 400 psi
1—188 HP CP Keeler W.T. 1942 Oil 160 lb. W.P.
2—150 H.P. Cleaver Brooks Package 125 psi Heavy Oil 1946
1—150 HP CP Keeler W.T. 1947 Oil 150 lb. W.P.
1—100 H Verticle Hand Fired 100 lbs. Working Pressure
1—100 HP Clayton Forced Recirculation Compact Self-Contained and Fully Equipped for Operation 160 lb. W.P.
1—35 HP O and S Scotch Hand Fired 100 lbs. W.P.
1—25 HP Dowtherm Vaporizer
5—18 HP Red-Line New Horizontal Oil Fired 150 lbs. W.P.

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	1500	Al. Ch.	sl. rg.	2300	514
1	1000	G.E.	K	2300	1800
1	1000	West.	CW	2300	450
1	700	West.	CS	2300	1800
1	500	Al. Ch.	Syn.	2300	212
1	500	AC	ARX	2300	1800
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
1	350	G.E.	MT18	2300	400
1	200	West.	CS	2200	1800
1	200	G.E.	IM	440	600
1	125	West.	Syn. 3 brg.	550	600

"Everything from a Pulley to a Powerhouse"

TURBO GENERATORS

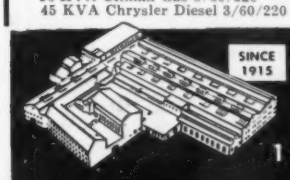
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 20 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936
1—187 KVA West. Non-Cond. New 1930 3/60/440 110 psi 10 lb. B.P.
1—94 KVA Worthington Non-Cond. 3/60/220 140 psi 5 lb. B.P.
1—50 KVA 1200 rpm Century generator (New 1949) Dean Hill Non-condensing turbine
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

1—1690 CFM Sullivan W. J. 3.22x13x16
1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—978 CFM Sullivan 13x13x8, 45 psi.
1—670 CFM Chicago OCE Syn Mtr. Dr. 3/60/2300
1—396 CFM Sullivan WL60 125 psi Direct Drive 75 HP 3/60/440
1—368 CFM Chi. NSB, 12x10, 100 psi.
1—371 CFM Schramm 7⅛x5x4, 100 psi
1—173 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
1	750	O'Brien (New)	13200	480	3
3	667	Al. Ch.	33000	2300	1
3	500	West. Dry	33000	2300	1
3	500	West.	22000	460	1
1	500	Gregory	4160	440	3
3	500	GE	13200	2300	1
3	400	GE	2400	480	1
3	333	West. Dry	2400	480	1
3	333	West. (1945)	33,000	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	250	Al. Ch.	13,200	115/230	1
2	250	West. Dry	13800	230	1
3	150	West	2300	230/115	1
3	150	Dry	2300/4160	230/460	1
3	100	Dry	2300/4160	230/460	1
3	100	West.	4160	240/480	1
3	85	West.	4160	120/240	1



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MOTORS MG SETS

Qty.	HP	Make	Voltage	Speed
12	3000	West.	525/600	600 RPM
26	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	220	500/1195 RPM
3	800	West.	525/600	600/900 RPM
1	650	Cr. Wh.	230	475/720 RPM
1	500	West.	230	250/500 RPM
1	400	G.E.	230	180/360 RPM
7	400	Elliott (new)	230	400/800 RPM
5	400	West. (new)	230	375/750 RPM
2	350	Cr. Wh.	230	400/800 RPM
1	200	Cr. Wh.	230	500/750 RPM
1	200	Cr. Wh.	230	375/750 RPM

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Turbo-generator sets, 625, 1000 KW, 480 v.
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Portable cranes, Whirley, crawler, track type.
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Rotary dryers, kilns: 8x125, 7x125, 54"x40'.

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1560 KVA Wghse. 3/60/2300 v Mon. Cond. —Bleeder TURBO unit

625 KVA Al Chal TURBO unit, non-cond. 3/60/480/240 v.

250 KVA (2) Wghse 3/60/480/240 v—7 cyl. DIESEL units

200 KVA (2) GE. 480/240 v—Buckeye 6 cyl. Diesels

125 KVA GE 3/60/440/220 v—Sterling GASOLINE unit

800 HP (2) B&W 250# BOILERS

680 HP (4) B&W 260# BOILERS

500 HP (3) B&W 160# low head BOILERS

300 HP (2) Keeler 250# PACKAGE BOILERS

300 (2) B&W 160# low head BOILERS

250 HP (2) B&W 225# low head BOILERS

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37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2200	Whse.	450
500	2200/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
300	2200/440	G. E.	720
300	440	G. E. (hoist)	600
300	2200	G. E.	360
300	440	Whse.	3600
250	440/220	Whse.	600
250	550/440	G. E.	1200
200	440/220	Whse.	514
150 (2)	440/220	G. E.	720
150	2200/440	G. E.	600
135	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2200	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G. E.	ATI	720
375	440/220	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G. E.	TS	720
300	2200/440	G. E.	TS	1200
250	2200/440	G. E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G. E.	ATI	600
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G. E.	FT	3600
500	2200/4000	Elliot	SC	1800
500	2200	G. E.		450
400	2200/400	Whse.	CS	720
300	2200	L. Allis	FS	1800
225 (2)	2300/440	G. E.	KT	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2200/440	G. E.	JK	600
200	2200	G. E.	KT	1800
150	440/220	Whse.	CS	900
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G. E.	IK	450
150	440/220	G. E.	KT	720
150	2200/440		KT	600

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 480/220 V., G.E.
1—225 kva, 600 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm, 2200/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V., G.E.
1—FKR-143, 1200 amp., 4500 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
90	230	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2200/440	Syn.	125
65	G. E.	2200/440	sq. ca.	250

TRANSFORMERS 60 Cy.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—200 kva, G. E., 2200—575 V.
3—200 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—480/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

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In excellent Condition

Non-Condensing, Steel case 80# back pressure .8 P.F., 3 phase, 60 cycle, 4160/2300 volts, alternating current, complete with accessories, switchboard, oil circuit breaker and direct connected exciter. Only operated alternately for six years. Ideal for Chemical, Rubber, Petroleum. Textile, Pulp and Paper, and Sugar Refining Industries.

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1—Kennedy Van Saun 3' D x 6' L Contin. Steel Lined Ball Tube Mill

1—Allis-Chalmers 6' D x 16' L Contin. Steel Lined Ball Mill

BOILERS

2—Cleaver Brooks OB-35 Package Boilers, oil fired, 350 HP, 125# Pr.

2—Henry Vogt 1000 HP

1—Vogt Waste Heat, 248 HP, 178# Pr.

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3—333 KVA GE type H form K2DA —1 ph 60 cycle transformers 13800 volts primary, 460 volts secondary, ser. #6417472—3 & 4.

125 VOLT DC GENERATORS

KW	Make	Speed
200	West.	900
150	Westg.	1200
150	Westg. (3)	900
100	Cr. Wh.	1200
100	E.M.	1200
100	G. E. (2)	900
100	Westg.	1200
100	Westg. (2)	900
75	G. E. (2)	1200
50	Westg. (2)	1150

250 VOLT DC GENERATORS

KW	Make	Speed
2000	G. E.	NEW
1150	G. E.	NEW
750	G. E. (2)	NEW
400	G. E.	NEW
250	Cr. Wh.	1200
200	El. Mchy.	900
150	G. E.	1200
125	G. E. (2)	1200
125	E. D.	1750
100	Delco (4)	1150
75	Westg.	900
75	Cr. Wh.	1150

SYNCHRONOUS CONDENSER

1250 KVA Westg., 480 volts, 1200 RPM, with 15 KW direct connected Excitor. Late modern. Complete.

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1—500 KW, 240 V D.C., Whse. M-G Set, 900 RPM, Syn. Drive, 3/60/2200. Ser. 4979926 with magnetic reduced voltage starter.
3—400 KW—270 V DC G.E. 3/60/2300/900 RPM Syn. Drive. 3 Brg. Complete w/AC & DC panels. Ser. #4,098,425-26-65.
1—200 KW, 125 V D.C., Type PED, Ser. 576881, E-M Set, 900 RPM, Syn. drive. 3/60/2300 (4160.)

TURBO-GENERATOR

1—750 KW, Elliott AC Generator, Frame 3232, 3600 RPM, 3/60/180. Elliott Turbine, Inlet 200# ga. 112 deg. F. superheat. 28" hg. vac. exhaust. Complete with accessories.

SYNCHRONOUS CONDENSER

1—1000 KVA, Allis-Chalmers, 3 phase, 60 cycle, 2300 volts, 600 RPM

SYNCHRONOUS MOTORS

1—200 HP, F-M, 300 RPM, Type TZO, Frame 5
1—200 HP, E-M, 900 RPM, Type PED, 2300/4160V
1—150 HP, G.E., 277 RPM, Type ATI, 2300V

MOTORS

Amt.	HP	Speed	Make	Type	Frame
3	250	600	G.E.	KT568 (2200V.)	
1	150	1800	Whse.	CS(2200V.)	8718
1	150	1800	A-C	2200V.	
1	150	900	G.E.	I-K(220&V.)	15
1	125	1800	Whse.	CS	
1	100	1800	Whse.	CS	663C
1	100	1200	Whse.	CS	752C
1	100	900	G.E.	MT356 Slpr	
1	100	900	A-C	2300V.	

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10—AC GE H5—5 A
16—AC West. 260—5 A
13—AC West. SM—5/1500

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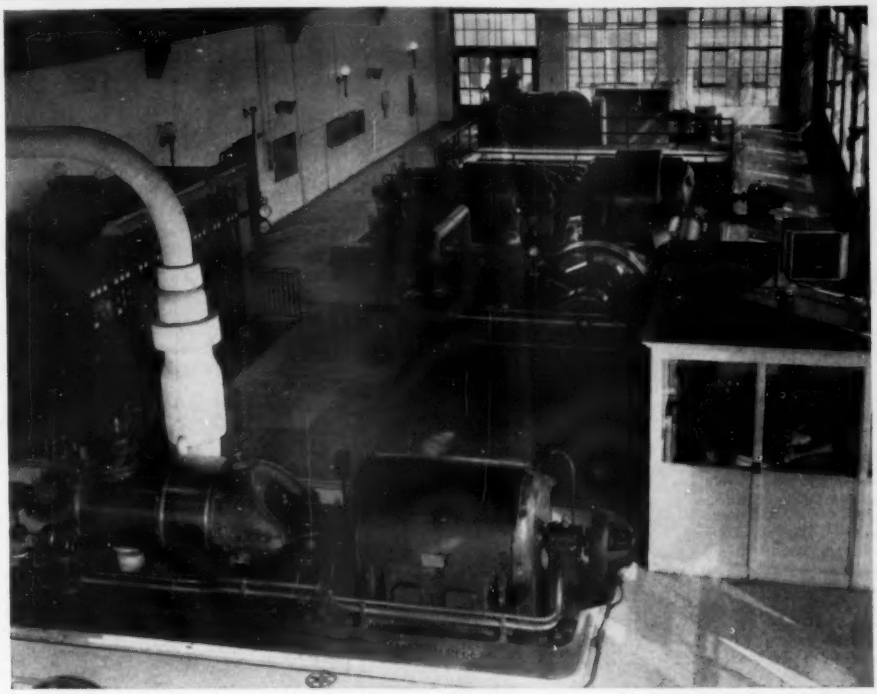

Complete 6500-KW Power Plant Consisting of the Following Principal Items

1—3000-KW Allis-Chalmers condensing high-pressure steam turbine generator unit. 3600 r.p.m. impulse reaction type turbine direct connected to two-pole 60-cycle 3-phase 2300-4600 volt generator.
Throttle steam pressure lb. gauge 400.
Total throttle steam temperature 600°F.
Exhaust steam pressure 28″ vacuum.
Installed new 1949. (Including auxiliaries.)

1—1500-KW Allis-Chalmers turbo-generator, 2300 volts, 60-cycle, 3-phase. Installed new 1927. (Including auxiliaries.)

2—1000-KW Allis-Chalmers turbo-generators, 2300 volts, 60-cycle, 3-phase. Installed new 1918. (Including auxiliaries.)

1—Set of Metal Clad Switchgear and control panels, for the above turbines.

1—50,000 lbs. per hr., 450 psi. Union Iron Boiler including Detroit Roto Stokers with traveling grates and complete auxiliaries. Installed new 1949.

2—35,000 lbs. per hr. 200 psi. Union Iron Boilers including Detroit Roto Stokers and complete auxiliaries. Installed new 1935 and 1937.

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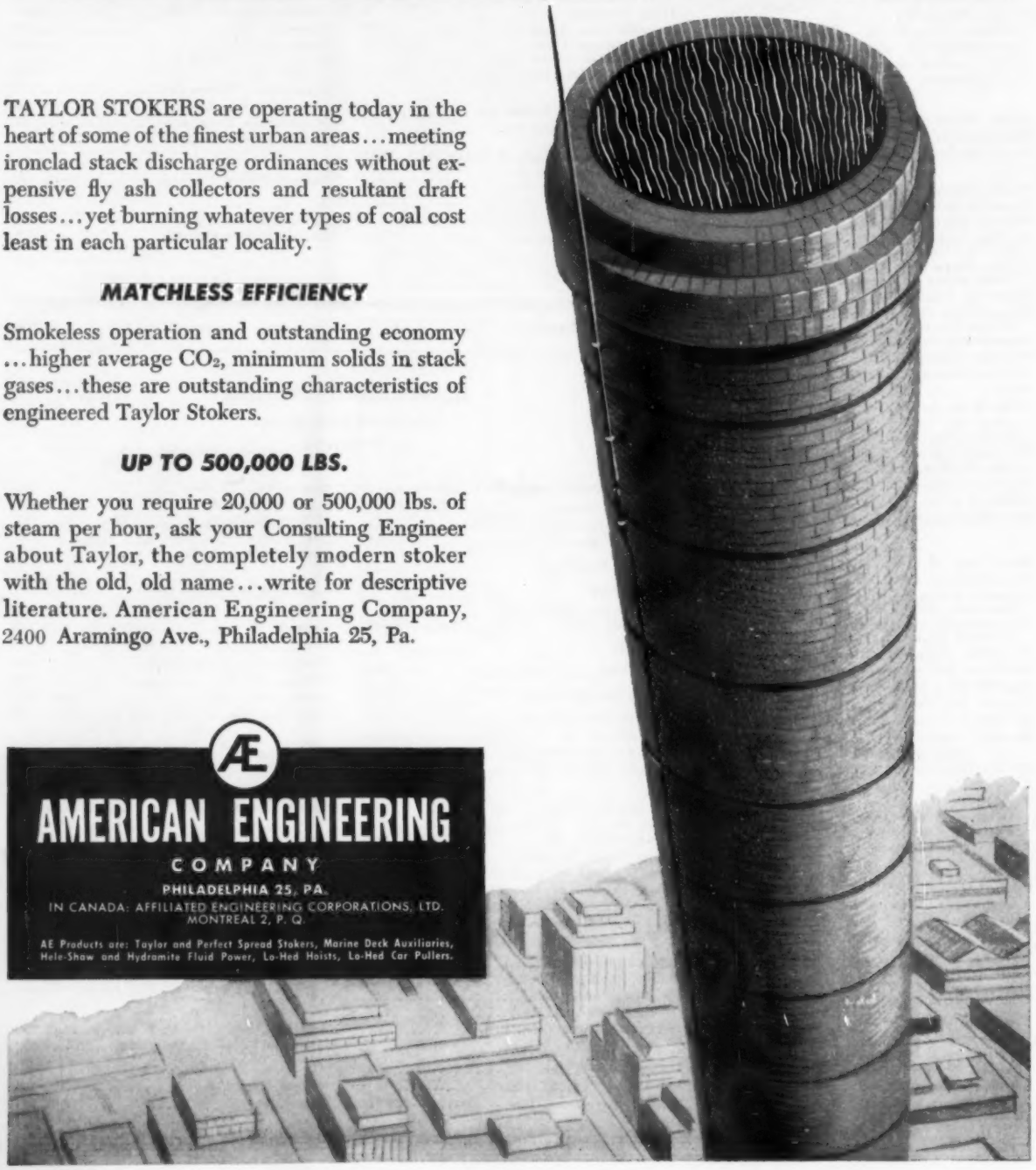

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may be had in

- **WROUGHT IRON**
- **ALUMINUM**
- **INCONEL**
- **PURE NICKEL & MONEL**
- **COPPER (Deoxidized)**
- **HASTELLOY ALLOYS, B & C**

Piping engineers can choose Grinnell Welding Fittings today from numerous materials having exceptional resistance to heat and cold, as well as the ability to cope successfully with troublesome fluids and gases.

Numbered among these are intermediate and high alloy steels containing chromium, nickel (or both)—plus other alloying elements such as molybdenum and copper. In addition, alloys are available which are composed primarily of nickel, copper or aluminum. Hastelloy Alloys B & C, developed primarily for severe chemical service, are also available.

Charted on this page are Grinnell Welding Fittings in a variety of materials and sizes.

**Covered in previous advertisements. Available on request.*

TYPE OF FITTING (All dimensions in inches)		WROUGHT IRON		ALUMINUM[1] Type 3S-F		INCONEL			NICKEL & MONEL			COPPER[2] Deoxidized		HASTELLOY ALLOYS B & C		
		Std. Wall	Ex. Str. Wall	Std. Wall	Ex. Str. Wall	Sch. 10	Std. Wall	Ex. Str. Wall	Sch. 10	Std. Wall	Ex. Str. Wall	Std. Wall	Ex. Str. Wall	Schedule 5	Schedule 10	Std. Wall
ELBOWS	90° Long Radius	½-12	½-12	½-16	½-16	½-12	½-12	½-12	½-12	½-12	½-12	½-24	½-24	½-8	½-8	½-8
	90° Short Radius	....	....	1-16	1½-16	....	....	....	....	....	....	....	....	....	....	....
	45° Long Radius	½-12	½-12	½-16	½-16	½-12	½-12	½-12	½-12	½-12	½-12	½-24	½-24	½-8	½-8	½-8
RETURNS	180° Long Radius	....	....	½-16	½-16	½-12	½-12	½-12	½-12	½-12	½-12	½-24	½-24	....	....	....
	180° Short Radius	....	....	1-16	1½-16	....	....	....	....	....	....	....	....	....	....	....
TEES	Straight Outlet	½-12	½-12	½-16	½-16	½-12	½-12	½-12	½-12	½-12	½-12	½-16	½-16	½ & Larger	½ & larger	½ & larger
	Reducing Outlet	½-12	½-12	½-16	½-16	½-12	¾-12	¾-12	½-12	¾-12	¾-12	¾-16	¾-16	½ & larger	½ & larger	½ & larger
CROSSES	Straight Outlet	....	....	½-12	½-12	....	....	....	....	....	....	....	....	....	....	....
	Reducing Outlet	....	....	½-12	½-12	....	....	....	....	....	....	....	....	....	....	....
REDUCERS	Concentric	1-12	1-12	½-16	½-16	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	½ & larger	½ & larger	½ & larger
	Eccentric	1-12	1-12	½-16	½-16	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	¾-12	½ & larger	½ & larger	½ & larger
STUB ENDS	ASA Length	½-12	½-12	½-24	½-24	½12-	½-12	½-12	½-12	½-12	½-12	½-12	½-24	½ & larger	½ & larger	½ & larger
	Short Length	....	....	....	....	½-12	½-12	½-12	½-12	½-12	½-12	....	....	½ & larger	½ & larger	½ & larger
CAPS		¾-12	¾-12	½-24	½-24	½-12	½-12	½-12	½-12	½-12	½-12	½-24	½-24	½ & larger	½ & larger	½ & larger

1. Type 2S-F Alclad, 3S-F, and Type 61S-T6 also available.

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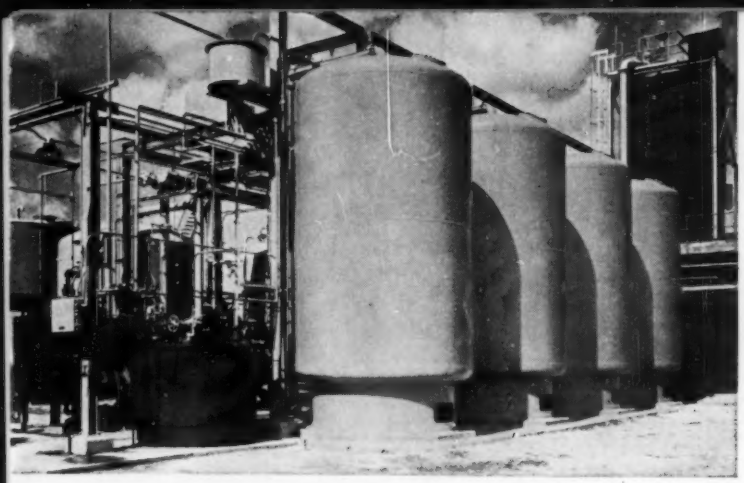
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



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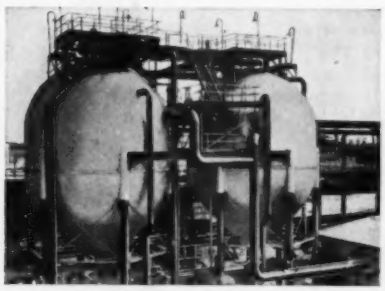
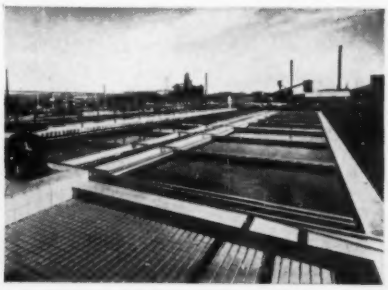
WHICH Permutit Process will solve YOUR water problem?



Sludge-Blanket Hot Lime-Soda Softener *reduces hardness . . . silica . . . alkalinity and turbidity. Fully utilizes Permutit sludge-blanket principle to improve performance.*



Precipitator *clarifies and softens cold water. Uses less space, time and chemicals than previous designs. Removes hardness, turbidity, color, iron, manganese. Reduces silica, alkalinity.*

Deaerating Heater *removes troublesome oxygen and CO_2. Prevents corrosion and pitting of feed lines, stage heaters, economizers and boilers at high temperatures. Steam is used twice . . . deaerates water completely.*

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Permutit Sales Engineers work with a complete range of equipment—all types, all sizes. They do not have to compromise by trying to fit one specific process to your plant.

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For aid in solving your water problem, write to The Permutit Company, Dept. P-10, 330 W. 42nd St., New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

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